CONTRACT NO.
71-712-7 #1

PROJECT MANUAL

VOLUME 2 OF 3

FOR

North Bay Water Reuse Program
Sonoma Valley County Sanitation District
Napa Salt Marsh Restoration Pipeline
(Carneros Reservoir to Huichica Unit)

Segment 1:
Carneros Reservoir to Huichica Parking Lot

Segment 2:
Huichica Unit

Sonoma Valley County Sanitation District

NOVEMBER 2012

DOCUMENT 00010

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STANDARD EDITION

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END OF DOCUMENT

Segment 1:

Carneros Reservoir to Huichica Parking Lot

DIVISION 2

SITE CONSTRUCTION

SECTION 02100

SITE PREPARATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Clearing, grubbing, disposal and protection for the purposes of site preparation.

B. The areas to be cleared, grubbed and stripped within public rights-of-way and utility easements shall be minimized to the extent possible for the scope of pipeline work and in consideration of the actual means and methods of construction used. No unnecessary site preparation within these areas shall be performed.

1.02 RELATED WORK

A. Trenching, Backfilling and Compaction is included in Section 02221.

B. Loaming and Seeding is included in Section 02930.

1.03 SUBMITTALS

A. Submit copies of permits required prior to clearing, grubbing, and stripping work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CLEARING

A. Cut and remove timber, trees, stumps, brush, shrubs, roots, grass, weeds, rubbish and any other objectionable material resting on or protruding through the surface of the ground.

B. Preserve and protect trees and other vegetation designated on the Drawings or directed by the OWNER to remain as specified below.

3.02 GRUBBING

A. Grub and remove stumps, roots in excess of 1-1/2-in in diameter, matted roots, brush, timber, logs, concrete rubble and other debris encountered to a depth of 18-in below original grade or 18-in beneath the bottom of roadway subbase whichever is deeper.

B. Refill grubbing holes and depressions excavated below the original ground surface with suitable materials and compact to a density conforming to the surrounding ground surface in accordance with Section 02221.

3.03 STRIPPING

A. Strip topsoil from areas to be excavated or filled.

B. Topsoil shall be free from brush, trash, large stones and other extraneous material. Avoid mixing topsoil with subsoil.

C. Stockpile and protect topsoil until it is used in landscaping, loaming and seeding operations. Dispose of surplus topsoil after work is completed.

3.04 DISPOSAL

A. Cut tree trunks and limbs exceeding 4-in in diameter shall be cut into 4-ft lengths.

B. Dispose of material and debris from site preparation operations by hauling such materials and debris to an approved offsite disposal area. No rubbish or debris of any kind shall be buried on the site.

C. Burning of cleared and grubbed materials or other fires for any reason will not be permitted.

3.05 PROTECTION

A. Trees and other vegetation designated on the Drawings or directed by the OWNER to remain shall be protected from damage by construction operations by erecting suitable barriers, guards and enclosures, or by other approved means. Conduct clearing operations in a manner to prevent falling trees from damaging trees and vegetation designated to remain and to the work being constructed and so as to provide for the safety of employees and others.

B. Maintain protection until work in the vicinity of the work being protected has been completed.

C. Do not operate heavy equipment or stockpile materials within the branch spread of existing trees.

D. Immediately repair any damage to existing tree crowns, trunks, or root systems. Roots exposed and/or damaged during the work shall immediately be cut off cleanly inside the exposed or damaged area.

E. When work is completed, remove dead and downed trees. Live trees shall be trimmed of dead and diseased limbs and branches. Cuts shall be cleanly made at their juncture with the trunk or preceding branch without injury to the trunk or remaining branches.

F. Restrict construction activities to those areas within the limits of construction designated on the Drawings, within public rights-of-way, and within easements provided by the OWNER. Adjacent properties and improvements thereon, public or private, which become damaged by construction operations shall be promptly restored to their original condition, to the full satisfaction of the property owner.

END OF SECTION

SECTION 02140

DEWATERING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Removal and disposal of surface water and ground water entering excavations.

1.02 RELATED WORK

A. Excavation and backfill is included in Section 02221.

1.03 SUBMITTALS

A. Submit shop drawings showing details of dewatering system including proposed areas for drainage disposal.

B. Submit copies of permits obtained for or related to the disposal of water.

PART 2 PRODUCTS

2.01 MATERIALS

A. Piping, pumping equipment and other materials required to provide dewatering of excavations shall be suitable for the intended purpose. Standby pumping units shall be maintained at the site to be used in case of failure of the normal pumping units.

PART 3 EXECUTION

3.01 DEWATERING AND DRAINAGE SYSTEM

A. During construction, provide and maintain proper equipment and facilities to remove water entering excavations, and keep such excavations dry so as to obtain a satisfactory undisturbed subgrade foundation condition until the fills, structures or pipes to be built thereon have been completed to such extent that they will not be floated or otherwise damaged by allowing water levels to return to natural levels.

B. Conduct dewatering in such a manner as to preserve the undisturbed bearing capacity of the subgrade soils at proposed bottom of excavation. Construct well or sump installation with proper sand filters to prevent drawing of finer grained soil from the surrounding ground.

C. Collect water entering the excavation from surface runoff in shallow ditches around the perimeter of the excavation, drain to sumps and pump from the excavation to maintain a bottom free from standing water.

D. Take additional precautions to prevent uplift of any structure during construction. Such arrangements shall be subject to the approval of the OWNER.

E. Dispose of drainage so that flow or seepage back into the excavated area to be prevented.

F. Prevent flotation by maintaining a positive and continuous operation of the dewatering system. If for any reason the dewatering system is found to be inadequate, make additions, changes and replacements, as necessary, to provide a satisfactory system at no additional cost to the OWNER. Damage resulting from failure to properly dewater excavations shall be repaired to the satisfaction of the OWNER at no additional cost.

END OF SECTION

SECTION 02151

JACKING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Steel casing pipe, skids, casing seals, coatings, location markers and miscellaneous appurtenances as required to complete the installation.

B. Work shall comply with the requirements of the Sonoma Marin Area Rail Transit, hereinafter referred to as the Railroad Company.

1.02 RELATED WORK

A. Site Preparation is included in Section 02100.

B. Dewatering is included in Section 02140.

C. Trenching, Backfilling and Compaction are included in Section 02221.

D. Excavation Support and Protection are included in Section 02311.

E. Erosion and Sedimentation Control are included in Section 02270.

F. Steel Casing Pipe is included in Section 02322.

G. Settlement Monitoring is included in Section 02445

H. Work in Railroad Property is included in Section 02450.

I. Ductile Iron Pipe and Fittings are included in Section 02616.

J. High Density Polyethylene Pipe and Fittings are included in Section 02623.

K. Polyvinyl Chloride (PVC) Pressure Pipe is included in Section 02622.

L. Loaming and Seeding are included in Section 02930.

M. Concrete work is included in Division 3.

N. Field Painting is included in Section 09901.

O. Corrosion Monitoring is included in Section 16641.

1.03 SUBMITTALS

A. Submit complete shop drawings and product data for casing pipe, carrier pipe, fittings and related appurtenances. Submit a lay schedule showing stationing, elevations, pipe classes and class coding.

B. Jacking system designs shall be prepared by a licensed professional engineer, registered in the State of California. Submit an original and three copies of the licensed professional engineer's certification, on the PE form, stating that the jacking system designs have been prepared by the professional engineer and that the professional engineer will be responsible for their execution. Do not submit jacking designs or drawings unless requested in writing.

C. Submit the proposed methods of jacking. Submittals shall consist of design drawings, calculations and related supplemental information describing in detail the design concept for jacking operations. Submittals shall be prepared by a licensed professional engineer, registered in the State of California. Submittals shall include as a minimum the following:

1. Shop drawings showing size, location and design calculations for reaction blocks and jacking pits.

2. Number and capacities of jacks.

3. Size, arrangement and installation of soil stabilization and dewatering equipment with details of locations where groundwater will be directed during construction.

4. Detailed descriptions of equipment, materials, sequence and procedures for jacking steel sleeve with shield including provisions for standby and backup equipment.

5. Revisions to shop drawings, as necessary, to accommodate field conditions and/or compliance as specified herein.

D. Should the owner of a right-of-way over the work require approval of jacking designs and shop drawings, furnish submittals to that owner and obtain the necessary approvals prior to furnishing the submittals specified above.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM A36 - Standard Specification for Carbon Structural Steel.

2. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

3. ASTM A139 - Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4-in and over).

4. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar.

5. ASTM C150 - Standard Specification for Portland Cement.

6. ASTM C207 - Standard Specification for Hydrated Lime for Masonry Purposes.

B. American Water Works Association (AWWA)

1. AWWA C200 - Steel Water Pipe - 6-in (150 mm) and Larger.

2. AWWA C203 - Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied.

3. AWWA C206 - Field Welding of Steel Water Pipe.

C. American Railway Engineering and Maintenance of Right-of-Way Association (AREMA)

1. AREMA Manual for Railroad Engineering, Volume 1: Track Chapter 1, Roadway and Ballast.

D. American Welding Society (AWS)

E. Where reference is made to one the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. Steel casing pipe shall be the product of a single domestic manufacturer. Pipe shall be tested and inspected at the foundry as required by the standard specifications to which the material is manufactured. Submit sworn certificates of such tests, results and satisfactory approvals.

B. Pipe to be installed under this Contract may be inspected at the site of manufacture for compliance with this Section by an independent laboratory selected by the OWNER or by the OWNER. The manufacturer's cooperation shall be required in these inspections. The cost of any inspection requested by the OWNER of pipe approved for this Contract shall be borne by the OWNER. The cost of inspection of any disapproved pipe shall be borne by the CONTRACTOR.

C. Welders shall be certified in accordance with standards of the AWS. Submit current certifications prior to the start of field work.

1.06 SYSTEM DESCRIPTION

A. The completed installation shall be suitable for transporting recycled water without affecting the stability and integrity of the overlying roadways or railroads.

1.07 DELIVERY, STORAGE AND HANDLING

A. Care shall be taken in loading, transporting and unloading to prevent injury to the pipe or coatings. Pipe shall not be dropped. Any damage to the pipe coatings shall be repaired in accordance with the procedures specified in Section 09901.

B. Pipe shall be subjected to a careful inspection prior to being installed. If any pipe fails to meet the requirements specified herein, it shall be removed and replaced with satisfactory pipe.

1.08 PROJECT/SITE REQUIREMENTS

A. Discharge from dewatering operations shall be handled in accordance with applicable regulatory requirements.

B. Inspect the locations where jacking operations will be conducted and the casing pipe is to be installed, verify the conditions under which the work will be performed, and provide necessary details, whether shown or specified on the Drawings or not, for the orderly prosecution of the work.

C. Jacking operations shall not result in measurable settlement, movement, or cracking of roadways, railroads or adjacent structures. If any movement or settlement occurs which causes or might cause damage to roadways or structures over, along, or adjacent to the work, jacking operations shall stop immediately except for those activities which will assist in making the work secure and prevent further movement, settlement, or damage. Jacking operations may resume only after necessary precautions have been taken to prevent further movement, settlement, or damage.

D. Roadways, railroads and structures damaged by jacking operations shall be repaired or replaced as necessary to restore them to their condition prior to beginning jacking operations.

E. The underground classification for the 30” bore and jack required at the railroad crossing has been classified as “Potentially Gassy with Special Conditions”. This classification was determined by CalOSHA, permit is attached to the end of Section 01100 (Summary). CalOSHA shall be notified if sufficient quantities of flammable gas or vapors have been encountered underground.

1.09 DEFINITIONS

A. Casing pipe shall mean the outer sleeve that is installed by the bore and jack method.

B. Carrier pipe shall mean the pipe inserted within the casing pipe and which acts as the conveyor of liquid.

C. Jacking pit shall mean the pit in which the boring and jacking equipment is installed and from which both the casing pipe and carrier pipe are launched.

D. Exit pit or receiving pit shall mean the pit located at the end of the casing pipe remote from the jacking pit at the point where the carrier pipe emerges from the casing pipe.

PART 2 PRODUCTS

2.01 MATERIALS

A. Steel Casing Pipe

1. Additional information provided in Section 02322, Steel Casing Pipe.

B. Carrier Pipe

1. Carrier pipe joints within the casing pipe shall be restrained or harnessed.

2. Ductile iron pipe and fittings shall be as shown on the Drawings and as specified in Section 02616.

3. Polyvinyl Chloride (PVC) pressure pipe, including Fusible PVC, and fittings shall be as shown on the Drawings and as specified in Section 02622.

4. High density polyethylene pipe shall be as shown on the Drawings and as specified in Section 02623.

2.02 MIXES

A. Sand fill shall be of such sizes that when dry, 100 percent by weight shall pass a No. 20 sieve and not over 5 percent by weight shall pass a No. 100 sieve.

B. Mortar shall consist of 1 part cement, 1/4 part lime and 2 parts sand. Sand shall comply with ASTM C144. Lime shall comply with ASTM C207, Type S. Cement shall comply with ASTM C150, Type II.

C. Cement grout shall consist of a mixture of about 1 part cement to 6 parts sand. The amount of cement may be increased or decreased as necessary and as permitted to provide good flowing characteristics.

2.03 SURFACE PREPARATION AND SHOP COATINGS

A. Surface preparation of steel casing pipe shall be in accordance with Section 09901.

B. Steel casing pipe shall be protected inside and outside by a black bituminous coating with a minimum thickness of 5 mils.

PART 3 EXECUTION

3.01 PREPARATION

A. Notify OWNER, County, Caltrans, and/or Railroad Company as appropriate at least 7 days in advance of the planned start of work within the road or railroad right-of-way.

B. Jacking pit subgrades shall be kept continuously free from ground and surface waters during jacking operations. Additional groundwater controls may be ordered on short notice and shall be implemented as directed. Observed water levels prior to construction are to be below the invert elevation of the jacking pits. Groundwater control along and at the face of the jacking casing shall include chemical grout stabilization as required.

3.02 INSTALLATION

A. Dimensions of jacking and receiving pits shall be determined by the CONTRACTOR, subject to the approval of the OWNER.

B. Excavate jacking pit and provide excavation supports as required. Excavation support shall extend a sufficient depth below the invert of the steel casing pipe to resist any pressure developed by the soil outside the jacking pit. Excavation support shall extend at least 3-ft-6-in above existing grade.

C. Furnish a level concrete slab at the bottom of the jacking pit. Steel rails or beams shall be embedded in the concrete slab for placement and alignment of each piece of casing pipe or carrier pipe during installation operations.

D. Furnish, install and remove, to the extent required, thrust blocks or such other provisions as may be required in driving the casing pipe or carrier pipe forward.

E. Maintain proper alignment and elevation of the casing pipe consistently throughout the jacking operation.

F. Tolerances for installation of the casing pipe shall be as follows:

1. Elevation: to grade or a maximum of 9-in below grade.

2. Plan Location: plus or minus 1-ft.

G. Jacking operations for the casing pipe shall be continuous and precautions shall be taken to avoid interruptions which might cause the pipe to "freeze" in place.

H. Carrier pipe shall be supported within the casing pipe so that pipe bells do not rest directly on the casing. The load of the carrier pipe shall be distributed along the casing by the method of support as shown on the Drawings and as specified herein.

I. Dewatering through the casing pipe during construction will not be permitted.

J. Steel casing pipe sections shall have beveled ends with a single v-groove and shall be full penetration butt welded on the outside of the casing in accordance with the applicable portions of AWWA C206 and AWS D7.0 for field welded water pipe joints. Joints of the steel casing shall be butt welded prior to being subjected to the jacking operation. The welded joints shall be wire brushed and painted with bitumastic enamel coating in accordance with AWWA C203.

K. Jacking shall be performed in a manner to prevent voids from developing outside the jacking sleeve. A jacking shield shall be used to minimize the amount of voids produced during excavating in the forward end of the jacking sleeve. Voids which occur shall be filled with cement grout.

L. Furnish and install, and later remove to the extent required, thrust blocks or other provisions for backing up the jacks employed in driving the casing pipe forward.

M. Immediately following the jacking operation, pressure grout the jacked section to fill voids existing outside of the jacked casing. Grouting shall be from the interior of the casing through the grouting holes.

N. After the casing pipe has been completely installed, thoroughly clean the interior of the casing pipe and remove excess material leaving a smooth interior throughout.

O. The exit pit shall be excavated up to the casing pipe. Excavation support shall be provided as required. Sufficient room shall be provided to continue installation of carrier pipe, fittings and necessary connections to the system.

P. The carrier pipe shall be installed within the casing using skids as specified above. Carrier pipe shall be installed from the jacking pit end of the casing. Each joint shall be thoroughly checked prior to being inserted into the casing.

Q. Upon completion of installation of the carrier pipe inside the casing pipe, provide suitable restrained caps or plugs at each joint outside the end of the casing pipe and hydrostatically test the carrier pipe in accordance with Section 02622 for 30 minutes. There shall be no allowable leakage. Remove the carrier pipe from the casing and remake leaking joints. Repeat hydrostatic test until there are no leaks in the carrier pipe within the casing.

R. Construct an 8-in thick brick bulkhead after the carrier pipe has been installed and successfully hydrostatically tested. The portion of the carrier pipe passing through the brick bulkhead shall be wrapped with three layers of 15 lb asphalt impregnated felt before the bulkhead is constructed.

S. Fill void between casing pipe and carrier pipe completely with grout in one continuous uninterrupted operation in a manner to prevent the occurrence of any voids between the casing pipe and the carrier pipe.

T. Furnish concrete markers installed flush with grade at each end of the casing pipe showing size of casing pipe, depth from grade to top of casing pipe and located on the center line of the casing.

3.03 SITE RESTORATION

A. At the conclusion of jacking operations, remove excavation support systems for jacking pits. If withdrawal should damage or disturb the roadway subgrade, leave supports in place and cut off 36-in below finished grade.

B. Following pipe installation and backfill operations, restore the profile of the right-of-way to its original condition. Construct sidewalks and fencing, if applicable, to match existing. Install sodding or seeding to match existing, as required.

C. Remove equipment, supplies, excess excavation materials and miscellaneous items associated with the jacking operation and leave the site in a clean and tidy condition.

END OF SECTION

SECTION 02158

HORIZONTAL DIRECTIONAL DRILLING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Provide materials, equipment and incidentals necessary for the construction of new 14-inch and 18-inch diameter recycled water force main by horizontal directional drilling as shown on the Drawings and as specified herein. Horizontal Directional Drilling (HDD) is meant as a method of trenchless pipe installation using a steerable drilling operation which directly installs a pipe along a linear alignment (not necessarily horizontal) without an open hole or open face.

B. Furnish survey including layout, inspection and record-keeping incidental to the drilling and pipe installation.

C. Drilling shall be conducted at locations depicted in the drawings. Work must be conducted outside of nearby waterways.

D. Drilling shall either be conducted from a pit or as a sacrificial tangent curve to intersect the alignment outside of nearby waterways. Should a pit be used, work done to construct and maintain the pit will be part of this work.

1.02 RELATED WORK

A. Earthwork is included in Section 02200.

B. Fusible PVC is included in Section 02622

C. High density polyethylene pipe is included in Section 02623.

1.03 SUBMITTALS

A. Submit letters, shop drawings and product data showing materials of construction, installation equipment and details of installation for the HDD operation including:

1. Written certification from the manufacturer that the drilling equipment is capable of completing the planned installation, as indicated.

2. Proof of manufacturer's inspection and calibration of surveying equipment. Submit prior to the commencement of drilling operations.

3. Construction Procedures

a. HDD and Contingency Plan:

1. Obtain OWNER's approval of HDD and Contingency Plan prior to commencing HDD mobilization.
2. Indicate proposed staging areas and limits of HDD work.
3. Detailed descriptions of:

i. Methods
ii. Equipment:
1. Calibrations
2. Drawings
3. Photographs
4. Descriptions of any modifications since manufacture
iii. MSDS for materials to be used for the pipeline installations.

4. Examples of daily logs and records in accordance with paragraph 1.04 of this section.
5. Description of equipment used for tracking of the drill head and bore path. Procedures for operating the tracking/survey tools shall be described in the submittal, including measures to verify the accuracy of the equipment readings.
6. Drilling Fluid:
i. Properties of proposed drilling fluid
ii. Calculations on expected drilling fluid weights for stabilization of the bore hole.
7. Contingency plans for remediation of potential problems that may be encountered during the drilling operations, including:
i. Obstructions or unknown utilities
ii. Inadvertent drilling fluid returns (frac-out)
iii. Loss of circulation
iv. Deviation from planned bore paths
v. Inability to advance drill stem or pipe
vi. Drill stem or pipe twisted off or broken off in borehole
vii. Pipe collapse

b. Notifications

1. Variations in Plan and Profile. Document any variations between the actual plan and profile of the bore path and the locations indicated. Notify OWNER immediately upon discovery of any deviations.

c. Daily Logs and Records

1. Submit complete, legible, written daily logs and records as required paragraph 1.04.A. of this section and as directed by OWNER, within one business day of the date to which the logs and records correspond.

d. Written descriptions of the construction method and equipment to be used, and access pit sizes and locations required for equipment and material access.

e. Grouting techniques to be used for overexcavation if any, including equipment, pumping procedures, grout types, and mixtures.

f. Description of line and grade control.

g. Proposed procedures, materials and equipment for lubricating the exterior of the pipe during pulling.

h. Details of spoil removal system, including equipment type, number and disposal location.

i. Proposed methods, materials and equipment for removing and clearing obstructions so that the HDD can advance forward.

j. Procedures for locating and controlling the direction of the drilling operation.

k. Submit as built drawings showing plan and profile views of the installed pipeline, correctly referenced to project benchmarks and major site features.

1.04 QUALITY ASSURANCE

A. Daily Logs and Records. Maintain daily logs and records documenting drilling lengths, location of drill head, drilling fluid pressures and flow rates, drilling fluid losses, inadvertent returns, drilling times required for each pipe segment, any instances of retraction and re-drilling of the pilot bore or segments thereof, and any other relevant observations. Maintain and update these records daily, or more frequently if directed by OWNER. The position of the drill head shall be continuously tracked.

B. Advance Notice and Inspections. Provide at least 72 hours advance written notice to OWNER of the planned inception of major drilling activities, including pre-reaming, reaming, and pipe pullback. Perform work in the presence of OWNER, unless OWNER grants prior written approval to perform such work in OWNER's absence.

C. Surveying Equipment and Procedures. Equipment used for tracking the bore path and drill head shall be inspected and calibrated by the equipment manufacturer prior to use.

1.05 PROJECT/SITE REQUIREMENTS

A. Boring locations are as indicated on the drawings. The boring logs indicate the soil and groundwater conditions at the boring location at the time of the boring and conditions can change away from the actual boring location and with time. The boring logs and geotechnical technical memorandum are available to the CONTRACTOR for his information to be used at his own risk. The CONTRACTOR is responsible for any conclusions to be drawn from the borings including the character of the materials to be encountered and the degree of difficulty to be expected in the performance of the work.

B. Do not assume that materials other than those disclosed by the borings will not be encountered or that the proportions and character of the various materials will not vary from those indicated in the boring logs.

PART 2 PRODUCTS

2.01 MATERIALS

A. On Drawing C-002, the carrier pipe shall be 14-inch diameter Fusible PVC (or 18-inch diameter high density polyethylene pipe) with dimension rations as shown on the drawings and as specified in Section 02626 and Section 02622.

B. On Drawing C-007, the carrier pipe shall be 18-inch diameter Fusible PVC (or 24-inch diameter high density polyethylene) pipe with the dimension ratios as shown on the drawings and as specified in Section 02626 and Section 02622.

C. Cement grout shall consist of a mixture of 1 part cement to 6 parts sand. The amount of cement may be increased or decreased as necessary and as permitted by the OWNER to provide good flowing characteristics.

D. Lubricant shall be bentonite or polymer based slurry.

2.02 EQUIPMENT

A. The drill rig and associated equipment shall be in good condition and capable of completing the project without significant delays.

B. The drill bit and reamers shall have a closed face and shall be capable of supporting the excavated area (face) during excavation and shutdown. The bit shall be full directional in both the horizontal and vertical directions from the drill rig so that the alignment can be maintained during the entire drilling operation.

C. The drill bit shall be capable of drilling though materials encountered including sand, gravel, glacial till and outwash, organics and marine clay.

D. Surveying equipment required for completing the as-built drawings.

PART 3 EXECUTION

3.01 ACCESS PITS/PREPARATION

A. Excavation, trenching, dewatering, sheeting, shoring and bracing shall comply with applicable requirements of OSHA, Sonoma County, Napa County, and these specifications.

B. Locate and protect existing utilities as required. Coordinate utility protection with the respective utility companies.

C. No rescue shafts will be allowed within the limits of nearby waterways.

3.02 PILOT BORE ALIGNMENT LAYOUT

A. Before drilling is allowed to begin, layout the pipeline alignment. There shall be at least one alignment point every 25 feet. Each alignment point shall show the ground elevation, designed pipeline invert elevation, corresponding pilot bore elevation, and the difference between the ground and pilot bore elevations.

B. Continuously monitor horizontal and vertical position and record the position at least once per drill steam length, or at 25 feet or 30-minute intervals, whichever is most frequent.

3.03 HDD OPERATIONS

A. Though the installation process may be licensed or proprietary in nature, the CONTRACTOR shall not change any material, thickness, design, values or procedural matters stated in the submittals, without the prior knowledge and approval of the OWNER. The CONTRACTOR shall submit, in writing, full details about component materials, their properties and installation procedures and abide by them fully during the entire course of the work.

B. Ream the pilot hole to a diameter which is sufficiently sized to reduce forces applied to the pipe during pull back. Intermediate temporary pipes may be used as required to install final pipe.

C. If pulling equipment is not capable of monitoring pulling forces imposed upon the pipe, a weak link shall be between the pipe and the molehead/reamer in order not to exceed the safe pulling strength as prescribed by the pipe manufacturer.

D. Install a swivel between the molehead/reamer and pipe connection to minimize torsional stresses imposed on the pipe.

E. Pressure grout the annular space around the final pipe if the final ream produces a theoretical annular space of more than 0.2 cu ft per linear foot of pipe.

F. Directly install the recycled water line by making either a single or multiple passes with a directional drill to the lines and grades indicated.

G. Install the pipe with no interruption in traffic.

H. Install the pipe from either a pit which allows the pipe installation along the proposed grade directly or by drilling an initial sacrificial tangent section outside the limits of any nearby waterway which is then excavated and cut-off or turned down to make the pipe connection at the grades indicated.

I. Provide remote sensing at the drill rig to maintain alignment of the drilling operation and provided a profile and plan locations of the as-installed pipe.

J. Install final pipe as one continuous fused string. Install final pipe in a continuous operation without allowing the pipe to set in the ground unmoved.

K. Pull pipe into place without damaging the pipe joints or pipe sections. Replace any pipe damaged during installation at no additional cost to the OWNER.

L. Maintain proper lubrication during pipe installation to reduce the exterior friction and possibility of the pipe seizing in place.

M. Drill pipe thrust and torque shall be measured and recorded at least once per drill pipe length, or at 30 feet or 30-minute intervals, whichever is most frequent. Loss of circulation or sudden increase in torque or thrust shall be reported to the OWNER immediately. All thrust and torque measurements shall be made during pilot hole drilling, pre-reaming, reaming, pullback and shall be submitted with daily logs. Instances of thrust, torque, or pullback exceeding allowable limits shall be reported immediately to the OWNER.

N. Continuously monitor and record drilling fluid pressures and flow rates. The pressures shall be monitored at the pump discharge. These measurements shall be made during pilot hole drilling, reaming and pullback operations.

O. Measure and record drilling fluid viscosity and density at least three times per shift with at least two hours between readings, using calibrated Marsh funnel and mud balance. These measurements shall be included in daily logs submitted to the OWNER. Document modifications to the drilling fluids, by noting the types and quantities of drilling fluid additives, the dates and times when introduced, and the reason for the addition or modification.

P. Employ licensed surveyors to locate the entry and exit points, and to establish horizontal and vertical datum for the bore and the pipe layout and fabrication areas.

Q. To confirm no damage to the pipe, upon completion of insertion and pull back, perform a mandrel test on the pipeline.

3.04 MONITORING

A. Surface Settlement Monitoring

1. Make a visual inspection of the roadway from the each shoulder to look for signs of settlement on an hourly basis during the time of active drilling.

2. Establish surface settlement monitoring points on the shoulders of the roadway and at any intermediate points which may be accessible or as directed by Sonoma County and Napa County. Establish surface settlement monitoring points along the centerline of the pipe. Install additional monitoring points at locations deemed necessary.

3. Record location of settlement monitoring points with respect to construction baselines and elevations. Record elevations to an accuracy of 0.01 feet for each monitoring point location. Establish monitoring points at locations and by methods that protect them from damage by construction operations, tampering, or other external influences.

4. Monitor ground settlement directly above and 10-ft before and after any utility or pipeline intersection.

5. Ground Surface Movement. Settlement or heave of the ground surface along the HDD alignment shall not exceed 0.5-in.

B. Reporting Frequency

1. Submit records of readings daily from the various surface settlement monitoring points and visual observations along the centerline of the pipe.

2. Report any loss of ground, roadway cracking, depression or settlement or other unusual activities immediately.

C. HDD operations shall limit vibrations transmitted to surrounding structures so as not to cause damage.

D. Disposal of Wastes and Groundwater

1. The CONTRACTOR shall dispose of waste soils, slurries and other wastes in accordance with applicable regulations. No waste shall be left on-site following completion of the work.

2. The CONTRACTOR shall dispose of groundwater generated by dewatering operations and any surface water entering access pits in accordance with Section 02140.

3.05 MOVEMENT AND TOLERANCES

1. No more than 3-in horizontal and 3-in vertical deviation from design location shall be permitted in the position of the carrier pipe.

2. When the initial bore deviates from the design line or grade by amounts greater than that specified, return the pipe to design line or grade plus or minus the specified tolerance at a rate of not more than 1-in per 25 feet.

3. If either pipe is off design line or grade by an amount that requires redesign of the pipeline or associated structures, the CONTRACTOR shall do so at no additional cost to the OWNER.

END OF SECTION

SECTION 02200

EARTHWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Earth work and grading; placing and compacting backfill and fill; and disposal of unsuitable, waste and surplus materials.

1.02 RELATED WORK

A. Site Preparation is included in Section 02100.

B. Dewatering and Drainage are included in Section 02140.

C. Trenching, Backfilling and Compaction is included in Section 02221.

D. Fill and Backfill Materials are included in Section 02230.

E. Erosion and Sedimentation Control are included in Section 02270.

F. Excavation Support and Protection are included in Section 02311.

G. Loaming and Seeding are included in Section 02930.

1.03 SUBMITTALS

A. Submit the proposed methods of construction, including excavation, excavation support systems designs, backfilling and filling and compaction for the various portions of the work.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM D1557 - Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort.

2. Caltrans Test Methods (CTM) 216 – Method of Test for Relative Compaction of Untreated and Treated Soils

3. CTM 217 – Method of Test for Sand Equivalent

4. CMT 231 – Method of Test for Relative Compaction of Untreated/Treated Soils and Aggregates

1.05 QUALITY ASSURANCE

A. Prior to and during the placement of backfill and fill coordinate with the soils testing laboratory to perform in-place soil density tests to verify that the backfill/fill material has been compacted in

accordance with the compaction requirements specified elsewhere. The OWNER may designate areas to be tested.

1.06 DEFINITIONS

A. Where the phrase "in-the-dry" is used in this Section, it shall be defined to mean a soil condition such that the in-place moisture content of the soil at that time is no more than two percentage points above the optimum moisture content of that soil as determined by the laboratory test of the moisture-density relation appropriate to the specified level of compaction.

B. Where used in this Section "structures" refers to buildings, wet wells, manholes and below grade vaults. Stormwater structures and duct banks are not considered structures in this context.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 PREPARATION

A. Pot Holes

1. Perform exploratory excavation work (pot holes) for the purpose of verifying the location of underground utilities and structures and to check for unknown utilities and structures, prior to commencing excavation work.

2. Pot holes shall be backfilled as soon as the desired information has been obtained. Backfilled surfaces shall be stabilized in accordance with approved erosion and sedimentation control plans.

B. Dewatering and Drainage Systems

1. Temporary dewatering and drainage systems shall be in place and operational prior to beginning excavation work.

3.02 EXCAVATION SUPPORT

A. See Section 02311 Excavation Support and Protection.

3.03 STRUCTURAL EXCAVATION PROCEDURES

A. Excavations for structures shall be suitably wide for construction of the structures, including excavation supports, dewatering and drainage systems and working clearances.

B. Excavation shall be performed in-the-dry and shall be accomplished by methods which preserve the undisturbed state of subgrade soils. Drainage and dewatering systems shall be in place and operational prior to beginning excavation work. In no case shall the earth be plowed, scraped or excavated by any means so near to the finished subgrade that would disturb the finished subgrade. Hand excavation of the final 3 to 6-in may be required to obtain a satisfactory, undisturbed subgrade. Subgrade soils which become soft, loose, "quick", or otherwise unsatisfactory for support of structures as a result of inadequate excavation, dewatering, or other

construction methods shall be removed and replaced with lean concrete, compacted structural fill or suitable crushed rock, subject to prior approval by the OWNER at no additional cost.

C. Subgrade Preparation

1. Structures unless otherwise shown on the Drawings or otherwise specified herein:

a. Compact the top 12-in of subgrade to a minimum of 95 percent relative compaction (based on ASTM D1557 or CMT 216).

2. Where existing subgrade contains a significant amount of clay or cohesive soils, over-excavate sufficiently below the bottom of structure for placement of a lean concrete working mat. Prior to placing the lean concrete working mat, compact the top 12-in of existing, undisturbed subgrade to a minimum of 95 percent relative compaction (based on ASTM D1557 or CMT 216).

D. When excavations have reached the required subgrade, including any allowances for working mats or base materials, prior to the placement of working mats or base materials, notify the soils testing laboratory to verify the suitability of the existing subgrade soils for the anticipated foundation and structural loadings. If the existing subgrade soils are determined to be unsuitable, direction will be provided by the OWNER regarding removal and replacement with suitable materials. If CONTRACTOR believes that such direction would increase CONTRACTOR's cost and would thereby entitle CONTRACTOR to a change in Contract cost, CONTRACTOR shall notify the OWNER in accordance with the applicable article(s) in the General Conditions pertaining to changes in the work.

E. Over-excavation beyond the limits and depths required by the Contract Documents shall be replaced by lean concrete or other approved material subject to the prior approval of the OWNER at no additional cost.

3.04 GENERAL FILLING AND BACKFILLING PROCEDURES

A. See Section 02221 Trenching, Backfilling and Compaction.

3.05 EMBANKMENT FILL PROCEDURES

A. Prior to placing embankment fill materials, organic materials (including peat and loam) and loose inorganic silt material (loess) shall be removed from areas beneath the embankments. If the subgrade slopes are excessive, the subgrade shall be stepped to produce a stable, horizontal surface for the placement of embankment materials. The existing subgrade shall then be scarified to a depth of at least 6-in.

B. Embankment fill shall consist of common fill material and shall be placed and compacted in even lifts (measured before compaction) of 12-in.

C. Rock may be used in embankment fill only with prior, written approval of the OWNER.

3.06 IMPERVIOUS FILL

A. Impervious fill shall be placed in controlled, even lifts having a maximum thickness (measured before compaction) of 6-in. Compaction shall be sufficient to attain a permeability of less than $1x10^{-7}$ cm/sec.

B. Moisture content of impervious fill to be compacted shall be maintained at or near its optimum moisture content (minus 2 to plus 3 percent).

3.07 COMPACTION REQUIREMENTS

A. See Section 02221 Trenching, Backfilling and Compaction.

3.08 DISPOSAL OF UNSUITABLE, WASTE AND/OR SURPLUS EXCAVATED MATERIAL

A. See Section 02221 Trenching, Backfilling and Compaction.

3.09 GRADING

A. Grading shall be performed to the lines and grades shown on the Drawings. Objectionable material encountered within the limits indicated shall be removed and disposed of. Subgrades shall be completely and continuously drained and dewatered throughout the grading process. Install temporary drains, drainage ditches, or other means to intercept or divert surface water which may affect the execution or condition of grading work.

B. If at the time of grading it is not possible to place any material in its proper section of the WORK, it shall be stockpiled in approved areas for later use. No extra payment will be made for the stockpiling or double handling of excavated material.

C. Stones or rock fragments larger than 4-in in their greatest dimensions will not be permitted within the top 6-in of the finished grade of fills and embankments.

D. In cut areas, loose or protruding rocks in slopes shall be removed to line or finished grade of the slope. Cut and fill slopes shall be uniformly dressed to the slope, cross-section and alignment shown on the Drawings unless otherwise directed by the OWNER.

END OF SECTION

SECTION 02221

TRENCHING, BACKFILLING AND COMPACTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Trenching for pipelines and appurtenances, including drainage, filling, backfilling, disposal of surplus material and restoration of trench surfaces and easements.

B. Excavation shall extend to the width and depth shown on the Drawings or as specified herein and shall provide suitable room for installing pipe, structures and appurtenances.

C. Provide sheeting, bracing, and supports as approved. Dispose of excavated material the OWNER deems unsuitable for backfilling. The bottom of the excavation shall be firm, dry and acceptable to the OWNER. If conditions warrant, deposit gravel for pipe bedding, or gravel refill for excavation below grade, directly on the bottom of the trench immediately after excavation has reached the proper depth and before the bottom of the trench has become softened or disturbed by any cause whatever. The length of open trench shall be related closely to the rate of pipe laying. Excavation shall be made in open trenches.

D. Excavation, trenching and related sheeting, bracing, shall comply with the requirements of OSHA excavation safety standards (29 CFR Part 1926.650 Subpart P) and State requirements. Where conflict between OSHA and State regulations exists, the more stringent requirements shall apply.

E. Wherever the requirement for 95 percent compaction is referred to herein it shall mean "at least 95 percent of maximum density as determined by ASTM D1557, Method D or by CMT 216".

1.02 RELATED WORK

A. Dewatering is included in Section 02140.

B. Earthwork is included in Section 02200.

C. Pavement Repair and Resurfacing is included in Section 02576.

D. Loaming and seeding is included in Section 02930.

E. Controlled Density Fill is included in Section 03650.

PART 2 PRODUCTS

2.01 FILL MATERIALS

A. Pipe Bedding and Pipe Zone Material

1. Granular backfill material with the following characteristics:

a. Material Gradation

Sieve Size	Percent Passing by Weight
3/4 - inch	100
3/8 - inch	80-100
No. 4	30-80
No. 16	5-30
No. 200	0-5

b. Sand Equivalent = Minimum of 30, Maximum of 75

c. Durability = Minimum of 40

2. Caltrans Class 1A Permeable Material

3. Caltrans Class 2 Aggregate Baserock, (meeting requirements of the May 2006 CalTrans Standard Specifications) or

4. Controlled Low Strength Material (CLSM) or Controlled Density Fill (CDF) per SCWA Standard Drawing No. 108 and in accordance with Section 03650.

B. Trench Backfill

1. Trench backfill may consist of on-site soils, free of debris, concentrations of vegetation and rock larger than 3-inches in maximum dimension and meeting the requirements of paragraph 2.c, d and e below.

2. Import fill graded to have the following properties:

a. 95% to 100% passing the 3-inch sieve

b. 20% to 50% passing the #200 sieve

c. Plasticity Index not greater than 20

d. Liquid Limit less than 35

e. Expansion Index not greater than 20

3. CDF in accordance with Section 03650.

C. Class 2 Aggregate Base (Class II AB)

Class 2 aggregate base shall be ¾-inch maximum material conforming to Section 26-1.02A of the May 2006 Caltrans Standard Specifications.

2.02 GEOTEXTILE FABRIC

A. The geotextile fabric shall be a nonwoven fabric consisting of synthetic polymers formed into a stable network. The fabric shall be nonbiodegradable, resistant to ultraviolet light exposure, insect and rodent resistant and conform to the following minimum properties:

Properties	Value	Test Method
Fabric Weight (oz/sq yd)	7	ASTM D5261
Apparent Opening Size (mm)	70	ASTM D4751
Puncture Strength (lbs)	70, Min.*	ASTM D4833
Grab Tensile Strength (lbs)	120 Min.*	ASTM D4632
Grab Tensile Elongation (%)	50, Min.*	ASTM D4632

*Min. = Minimum Average Roll Value

B. Edges shall be selvaged or otherwise finished to prevent outer material form pulling away from geotextile.

C. Geotextile shall be Mirafi 140N; Supac equivalent, or approved equal.

2.03 BURIED WARNING AND IDENTIFICATION TAPE

A. Provide polyethylene plastic warning tape manufactured specifically for warning and identification of buried utility lines. Provide tape on rolls, 3 inches minimum width, color coded as specified below for the intended utility with warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification to read, "CAUTION, BURIED RECYCLED WATER LINE BELOW" or similar wording. Provide permanent color and printing, unaffected by moisture or soil

Warning Tape Color Codes

Purple: Reclaimed Water Systems

1. Warning Tape for Metallic Piping

Provide acid and alkali-resistant polyethylene plastic tape conforming to the width, color, and printing requirements specified above, with a minimum thickness of 0.003 inch and a minimum strength of 1500 psi lengthwise, and 1250 psi crosswise, with a maximum 350 percent elongation

2. Detectable Warning Tape for Non-Metallic Piping

Provide polyethylene plastic tape conforming to the width, color, and printing requirements specified above, with a minimum thickness of 0.004 inch, and a minimum strength of 1500 psi lengthwise and 1250 psi crosswise. Manufacture tape with integral wires, foil backing, or other means of enabling detection by a metal

detector when tape is buried up to 3 feet deep. Encase metallic element of the tape in a protective jacket or provide with other means of corrosion protection.

2.04 DETECTION WIRE FOR NON-METALLIC PIPING

A. Provide insulated single strand, solid copper detection wire with a minimum of 12 AWG for non-metallic piping as shown on the drawings.

PART 3 EXECUTION

3.01 TRENCH EXCAVATION

A. Trench excavation shall include material of every description and of whatever substance encountered, except rock and boulders. Pavement shall be cut with a saw, wheel or pneumatic chisel along straight lines before excavating.

B. Strip and stockpile topsoil from grassed areas crossed by trenches. At the CONTRACTOR's option, topsoil may be otherwise disposed of and replaced, when required, with approved topsoil of equal quality.

C. While excavating and backfilling is in progress, traffic shall be maintained; utilities and other property protected as provided in the General Conditions and General Requirements.

D. The bottom of the excavations shall be firm and dry and acceptable to the OWNER.

E. Excavation and dewatering shall be accomplished by methods which preserve the undisturbed state of subgrade soils. The trench may be excavated by machinery to, or just below the designated subgrade, provided that material remaining in the bottom of the trench is no more than slightly disturbed. Subgrade soils which become soft, loose, "quick", or otherwise unsatisfactory as a result of inadequate excavation, dewatering or other construction methods shall be removed and replaced as indicated on the plans or as required by the OWNER at the CONTRACTOR's expense.

F. Clay and organic silt soils are particularly susceptible to disturbance due to construction operations. When excavation is to end in such soils, use a smooth-edge bucket to excavate the last 1-ft of depth.

G. Where pipe is to be laid in screened gravel bedding, the trench may be excavated by machinery to the normal depth of the pipe provided that the material remaining in the bottom of the trench is no more than slightly disturbed.

H. Where pipe is to be laid directly on the trench bottom, final excavation at the bottom of the trench shall be performed manually, providing a flat-bottom true to grade upon undisturbed material. Bell holes shall be made as required.

I. At CONTRACTOR’s option, controlled density fill (CDF) may be used for pipe bedding and in pipe zone.

3.02 DISPOSAL OF MATERIALS

A. Excavated material shall be stacked without excessive surcharge on the trench bank or obstructing free access to hydrants and gate valves. Inconvenience to traffic and abutters shall be avoided as much as possible. Excavated material shall be segregated for use in backfilling as specified below.

B. It is expressly understood that no excavated material shall be removed from the site of the work or disposed of, except as directed by the OWNER. When removal of surplus materials has been approved by the OWNER, dispose of such surplus material in approved designated areas.

C. Should conditions make it impracticable or unsafe to stack material adjacent to the trench, the material shall be hauled and stored. When required, it shall be re-handled and used in backfilling the trench.

3.03 SHEETING AND BRACING

A. When moveable trench bracing such as trench boxes, moveable sheeting, shoring or plates are used to support the sides of the trench, care shall be taken in placing and moving the boxes or supporting bracing to prevent movement of the pipe, or disturbance of the pipe bedding and the screened gravel backfill.

1. When installing flexible pipe (such as PVC, Fusible PVC, HDPE), trench boxes, moveable sheeting, shoring or plates shall not be allowed to extend below mid-diameter of the pipe. As trench boxes, moveable sheeting, shoring or plates are moved, screened gravel shall be placed to fill any voids created and the screened gravel and backfill shall be recompacted to provide uniform side support for the pipe.

B. Steel sheeting may be used in lieu of wood sheeting wherever the use of sheeting is necessary. The cost for use of sheeting will be included in the bid items for pipe and shall include full compensation for driving, bracing and later removal of sheeting.

C. No payment will be given for sheeting or bracing, during the progress of the work. No payment will be given for sheeting which has actually been left in the trench for the convenience of the CONTRACTOR.

D. Sheeting driven below mid-diameter of any pipe shall remain in place from the driven elevation to at least 1-ft above the top of the pipe.

3.04 POTHOLES

A. Excavation of potholes may be required for the purpose of locating underground utilities or structures as an aid in establishing the precise location of new work.

B. Potholes shall be backfilled as soon as the desired information has been obtained. The backfilled surface shall be maintained in a satisfactory condition for travel until resurfaced as specified.

3.05 EXCAVATION BELOW GRADE AND REFILL WITH STABILIZATION MATERIAL

A. Whatever the nature of unstable material encountered or the groundwater conditions, trench drainage shall be complete and effective.

B. If the CONTRACTOR excavates below grade through error or for the CONTRACTOR's own convenience, or through failure to properly dewater the trench, or disturbs the subgrade before dewatering is sufficiently complete, he may be directed by the OWNER to excavate below grade as set forth in the following paragraph, in which case the work of excavating below grade and furnishing and placing the refill shall be performed at his own expense.

C. If the material at the level of trench bottom consists of fine sand, sand and silt or soft earth, the subgrade material shall be removed from the excavation and refilled as indicated in the plans with ¾" crushed rock stabilization material wrapped with geotextile filter fabric.

3.06 BACKFILLING

A. As soon as practicable after the pipe has been laid and jointed, backfilling shall begin and thereafter be prosecuted expeditiously. Bedding gravel, as specified for the type of pipe installed, shall be placed up to 1-ft over the pipe.

B. An impervious dam or bulkhead cutoff shall be constructed in the trench as shown on the drawings, to interrupt the unnatural flow of groundwater after construction is completed. The dam shall be effectively keyed into the trench bottom and sidewalls. Trench dams shall be CDF or CLSM.

C. Where the pipes are laid cross-country, the remainder of the trench shall be filled with common fill material in compacted layers not to exceed 8-inches and mounded 2-in above the existing grade or as directed. Where a loam or gravel surface exists prior to cross-country excavations, it shall be removed, conserved and replaced to the full original depth as part of the work under the pipe items. In some areas it may be necessary to remove excess material during the clean-up process, so that the ground may be restored to its original level and condition.

D. Where the pipes are laid in streets, the remainder of the trench up to a depth of 12-in below the bottom of the specified permanent paving shall be backfilled with the designated fill material in layers not to exceed 8-inches and thoroughly compacted. The subbase layer for paving shall be compacted in 6-in layers.

E. To prevent longitudinal movement of the pipe, dumping backfill material into the trench and then spreading will not be permitted until selected material or screened gravel has been placed and compacted to a level 1-ft over the pipe.

F. Backfill shall be brought up evenly. Each layer of backfill material shall be thoroughly compacted by rolling, tamping, or vibrating with mechanical compacting equipment or hand tamping. If rolling is employed, it shall be by use of a suitable roller or tractor, being careful to compact the fill throughout the full width of the trench.

G. Water jetting or puddling may not be used.

H. Where other methods are not practicable, compaction shall be by use of hand or pneumatic ramming with tools weighing at least 20 lbs. The material being spread and compacted in layers shall not over 6-in thick. If necessary, sprinkling shall be employed in conjunction with rolling or ramming.

I. Backfill around structures shall be selected common fill material, may be compacted by puddling where approved by the OWNER. Backfill shall be compacted, especially under and over pipes connected to the structures.

J. Subject to the approval of the OWNER, fragments of rocks and stones smaller than 3-in may be used in trench backfill providing that the quantity in the opinion of the OWNER is not excessive. Rock shall not be placed until the pipe has at least 2-ft of earth cover.

K. Bituminous paving shall not be placed in backfilling.

L. Road surfaces shall be broomed and hose-cleaned immediately after backfilling. Dust control measures shall be employed.

3.07 COMPACTION REQUIREMENTS

A. Beneath foundations and slabs on grade (except sidewalks): Compact the top 12-in of existing, undisturbed subgrade (and each layer of fill if applicable) to a minimum of 95 percent modified proctor (ASTM D1557) at or near its optimum moisture content (minus 2 to plus 3 percent).

B. 10-ft around structures: Compact the top 12-in of existing, undisturbed subgrade and each layer of fill or backfill to a minimum of 90 percent modified proctor (ASTM D1557) at or near its optimum moisture content (minus 2 to plus 3 percent).

C. Embankments (except under roadways), lawn or unimproved areas: Compact the top 6-in of existing, undisturbed subgrade and each layer of fill or backfill to a minimum of 90 percent modified protector (ASTM D1557) at or near its optimum moisture content (minus 1 to plus 4 percent).

D. Roads, paved areas and roadway embankments: Compact the top 12-in of existing, undisturbed subgrade and each layer of fill or backfill to a minimum of 95 percent modified proctor (ASTM D1557) at or near its optimum moisture content (minus 2 to plus 3 percent).

3.08 GEOTEXTILE INSTALLATION

A. Geotextile fabric shall be installed as shown on the drawings and in accordance with the manufacture's recommendations.

B. Overlaps shall be a minimum of 12 inches.

C. Maintain geotextile smooth and as free as practicable of tension, folds, wrinkles, or creases.

D. Fabric sections should be overlapped in accordance with the manufacturer's recommendations to reduce the potential for soil migration through the backfill.

3.09 RESTORING TRENCH SURFACE

A. Where the trench is adjacent to paved streets, in shoulders, sidewalks, or in cross-country areas, thoroughly consolidate the backfill and maintain the surface as the work progresses. If settlement takes place, immediately deposit additional fill to restore the level of the ground.

B. In and adjacent to streets, the trench backfill within 2.5 feet of the pavement surface shall consist of the following for the specified jurisdictions:

1. County of Napa – Structural backfill or compacted native material, relative compacted to 95%.

a. Duhig Road

i. Requires the use of CDF in lieu of 8" Class 2 AB and the intermediate trench backfill.

ii. Requires a 6" T-cut into existing AC on either side of the trench. The full trench width plus 1' into existing AC shall be replaced to match existing.

b. Buchli Station Road

i. Requires intermediate trench to be import fill or native fill at 95% relative compaction.

ii. Requires 8” Class 2 AB.

iii. Requires 2” AC overlay of full road width.

2. County of Sonoma - Structural backfill material per Section 19 of the State Standard Specifications, relative compacted to 90%. Pea Gravel shall not be used for structural fill.

a. Ramal Road

i. Requires a Caltrans Type II slurry seal applied over the full road width.

C. The surface of any driveway or any other area which is disturbed by the trench excavation and which is not a part of the paved road shall be restored to a condition at least equal to that existing before work began.

D. In sections where the pipeline passes through grassed areas, and at the CONTRACTOR's own expense, remove and replace the sod, or loam and seed the surface to the satisfaction of the OWNER.

END OF SECTION

SECTION 02270

EROSION AND SEDIMENTATION CONTROL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Installation of temporary access ways and staging areas, silt fences, stone filter boxes, stone filter berms, sediment removal and disposal, device maintenance, removal of temporary devices, temporary mulching, excelsior matting installation and final cleanup.

1.02 RELATED WORK

A. Earthwork is included in Section 02200.

B. Loaming and seeding is included in Section 02930.

1.03 SUBMITTALS

A. Technical product literature for commercial products, including straw mulch tackifier, to be used for erosion and sedimentation control.

1.04 QUALITY ASSURANCE

A. Be responsible for the timely installation and maintenance of sedimentation control devices necessary to prevent the movement of sediment from the construction site to off site areas or into the stream system via surface runoff or underground drainage systems. Measures in addition to those shown on the Drawings necessary to prevent the movement of sediment off site shall be installed, maintained, removed, and cleaned up at the expense of the CONTRACTOR. No additional charges to the OWNER will be considered.

PART 2 PRODUCTS

2.01 MATERIALS

A. Crushed stone for sediment filtration devices, access ways and staging areas shall conform to Caltrans Standard.

B. Berm structural stone shall be rip-rap as follows:

1. Rip-rap shall be sound, durable rock which is roughly rectangular shape and of suitable quality to insure permanence in the condition in which it is to be used. Rounded stones, boulders, sandstone or similar soft stone will not be acceptable. Material shall be free from overburden, spoil, shale and organic material, meet the OWNER’s approval and be well graded within the following limits:

Weight of Stone	Percent Finer by Weight
40 lb	100
12 lb	50
3 lb	0

C. Sediment Fence

1. Sediment fence shall be a prefabricated commercial product made of a woven, polypropylene, ultraviolet resistant material such as “Envirofence” by Mirafi Inc., Charlotte, NC or equal.

D. 1/4-in woven wire mesh for filter boxes shall be galvanized steel or hardware cloth.

E. Straw mulch shall be utilized on newly graded areas to protect areas against washouts and erosion. Straw mulch shall be comprised of threshed straw of oats, wheat, barley, or rye that is free from noxious weeds, mold or other objectionable material. The straw mulch shall contain at least 50 percent by weight of material to be 10-in or longer. Straw shall be in an air-dry condition and suitable for placement with blower equipment.

F. Latex acrylic copolymer or organic tackifier shall be a commercial product specifically manufactured for use as straw mulch tackifier.

G. An asphalt tackifier shall only be used when temperatures are too low to allow the use of a latex acrylic copolymer and only with prior written approval from the OWNER.

H. Erosion control blanket shall be installed in seeded drainage swales and ditches as shown on the Drawings or as directed by the OWNER. Erosion control blanket shall be 100 percent agricultural straw matrix stitch bonded with degradable thread between two photodegradable polypropylene nettings, such as Model S150 Double Net Short-Term Blanket (10 months) by North American Green, Evansville, IN or equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Sediment Fence Installation

1. Sediment fences shall be positioned as indicated on the Drawings and as necessary to prevent off site movement of sediment produced by construction activities as directed by the OWNER.

2. Dig trench approximately 6-in wide and 6-in deep along proposed fence lines.

3. Drive stakes, 8-ft on center (maximum) at back edge of trenches. Stakes shall be driven 2-ft (minimum) into ground.

4. Hang filter fabric on posts carrying to bottom of trench with about 4-in of fabric laid across bottom of trench. Stretch fabric fairly taut along fence length and maintain secure both ways.

5. Backfill trench with excavated material and tamp.

6. Install pre-fabricated silt fence according to manufacturer's instructions.

B. Construct filter boxes as detailed on the Drawings, from 1/4-in woven wire mesh or hardware cloth and wood. Fill with crushed stone and place over drop inlets and manholes to storm drain system as each inlet is completed. This should be done prior to setting casting, if there is a delay between installation of inlet structures or drain manholes and setting of castings. An alternate method is to ring each inlet with a sediment fence.

C. Stone Filter Berm Installation

1. Place berm structural stone across channel just below lower sandbag wall at work area. Face upstream side of structural berm with crushed stone.

D. Staging areas and access ways shall be surfaced with a minimum depth of 4-in of crushed stone.

3.02 MAINTENANCE AND INSPECTIONS

A. Inspections

1. Make a visual inspection of erosion and sedimentation control devices once per week and promptly after every rainstorm. If such inspection reveals that additional measures are needed to prevent movement of sediment to offsite areas, promptly install additional devices as needed. Sediment controls in need of maintenance shall be repaired promptly.

B. Device Maintenance

1. Sediment Fences

a. Remove accumulated sediment once it builds up to 1/2 of the height of the fabric.

b. Replace damaged fabric, or patch with a 2-ft minimum overlap.

c. Make other repairs as necessary to ensure that the fence is filtering runoff directed to the fence.

2. Filter Boxes

a. Replace crushed stone when it becomes saturated with silt.

3. Stone Filter Berm

a. Muck out trapped silt from dewatering operations when it has built up to within 6-in of the top of the berm.

b. Replace crushed stone filter when saturated with silt.

4. Add crushed stone to access ways and staging area as necessary to maintain a firm surface free of ruts and mudholes.

3.03 TEMPORARY MULCHING

A. Apply temporary mulch to areas where rough grading has been completed but final grading is not anticipated to begin within 30 days of the completion of rough grading.

B. Straw mulch shall be applied at rate of 100 lbs/1000 sq ft and tackified with latex acrylic copolymer at a rate and diluted in a ratio per manufacturer’s instructions.

3.04 EROSION CONTROL BLANKETS

A. Erosion control blankets shall be installed in seeded drainage swales and ditches as shown on the Drawings and as directed by the OWNER in accordance with manufacturer's instructions. The area to be covered shall be properly prepared, fertilized and seeded with permanent vegetation before the blanket is applied. When the blanket is unrolled, the netting shall be on top and the fibers in contact with the soil over the entire area. The blankets shall be applied in the direction of water flow and stapled. Blankets shall be placed a minimum of three rows (of 4-ft) wide (total approx. 12-ft width) within the drainage swale/ditch and stapled together in accordance with manufacturer's instructions. Side overlaps shall be 4-in minimum. The staples shall be made of wire, .091-in in diameter or greater, "U" shaped with legs 10-in in length and a 1-1/2-in crown. Commercial biodegradable stakes may also be used with prior approval by the OWNER. The staples shall be driven vertically into the ground, spaced approximately two linear feet apart, on each side, and one row in the center alternately spaced between each size. Upper and lower ends of the matting shall be buried to a depth of 4-in in a trench. Erosion stops shall be created every 25-ft by making a fold in the fabric and carrying the fold into a silt trench across the full width of the blanket. The bottom of the fold shall be 4-in below the ground surface. Staple on both sides of fold. Where the matting must be cut or more than one roll length is required in the swale, turn down upper end of downstream roll into a slit trench to a depth of 4-in. Overlap lower end of upstream roll 4-in past edge of downstream roll and staple.

1. To ensure full contact with soil surface, roll matting with a roller weighing 100 lbs/ft of width perpendicular to flow direction after seeding, placing matting and stapling. Thoroughly inspect channel after completion. Correct any areas where matting does not present a smooth surface in full contact with the soil below.

3.05 REMOVAL AND FINAL CLEANUP

A. Once the site has been fully stabilized against erosion, remove sediment control devices and accumulated silt. Dispose of silt and waste materials in proper manner. Regrade areas disturbed during this process and stabilize against erosion with surfacing materials as indicated on the Drawings.

END OF SECTION

SECTION 02311

EXCAVATION SUPPORT AND PROTECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Requirements for excavation and support of temporary excavations, and trenches. The CONTRACTOR shall design, furnish, install, and maintain a system of supports, including bracing and associated items, to retain excavations in a safe manner and to control ground movements. Upon completion of the required construction the system of supports shall be completely removed and the excavation and staging area sites restored as discussed herein.

B. Site grading; fencing and signing; construction staging areas; design and construction of excavation support systems; design and construction of thrust blocks; disposal of excavated material, surface water, and ground water; backfilling; and site restoration.

C. The design, equipment, materials, installation, protection, and monitoring of geotechnical instrumentation required to monitor the performance of the excavation support system as required herein.

D. Excavations and support systems shall conform to applicable OSHA excavation, trenching, and shoring standards which are contained in the U.S. Code of Federal Regulations 29 (C.F.R.) 1926.650-1926.653, other federal, state or local requirements.

1.02 RELATED WORK

A. Site Preparation is included in Section 02100.

B. Dewatering is included in Section 02140.

C. Earthwork is included in Section 02200.

D. Trenching, Backfilling and Compaction is included in Section 02221.

E. Settlement Monitoring is included in Section 02445.

1.03 SUBMITTALS

A. Submit the Shop Drawings and design calculations for the Contractor-designed excavation support system stamped by a Professional Engineer in the State of California. Submittals shall indicate the following, as a minimum:

B. Shop Drawings shall include:

1. Provide overall plan layout of the system, indicating clearances, dimensions, material properties, member sizes, locations, spacing and penetrations depth of members, locations of various types of lateral supports. Indicate existing and proposed utilities, structures or other

obstruction, location and type of instrumentation and monitoring points within the area of influence of the excavation.

2. Provide wall elevations and locations of bracing.

3. Show the overall sequence of installation and removal of bracing, indicating levels to which the work will be carried out before bracing is installed or removed.

4. Method of preloading bracing (if required) and the preload for each member, and the method of locking-off the preload. Include detailed drawings of the connections, jacking supports and method of shimming.

5. Details, layout, arrangement, equipment requirements, and method of construction of the proposed excavation support system.

6. Procedures for resolving difficulties arising from misalignment of members exposed during excavation, and criteria for implementing those procedures.

C. Design calculations shall include:

1. Loads on the excavation support system for the stages of excavation, bracing removal, and concrete placement, including material and equipment loads on adjacent ground during construction.

2. Design of wall and bracing members including details for the stages of construction.

3. Theoretical deflections of excavation support system and deformation of structures, pipelines, and other improvements located within the area of influence of the excavation.

4. Submit to the OWNER for review and acceptance, a plan of action to be implemented in the event any threshold value for deformation, as specified in Section 02445, is reached. The plan of actions shall be positive measures by the CONTRACTOR to limit further movement of the wall including but not limited to trenching for struts and wales, placement of granular earth berms against the wall, installation of additional struts, or combinations thereof. The details of the mitigating measures shall include a schedule of implementation, location and/or availability of materials, structural details for connections to the wall and support elements, and a detailed description of the method of implementation. The CONTRACTOR shall be prepared to work 24 hours per day to implement such measures. The remedial work/mitigating measures shall be at no additional cost to the OWNER.

D. Submit quality control measures as required to ensure that the performance of the excavation support system is consistent with the approved shop drawings and the requirements herein.

E. Submit welder qualifications and weld procedures in accordance with AWS D1.1.

F. At least one copy of the design shall be maintained at the job site during excavation that includes a plan indicating the sizes, types, and configurations of the materials to be used in the protective system, and the identity of the Professional Engineer who approved the design.

G. Design Engineer's documentation shall include:

1. On-site inspections of excavation support system as the systems are constructed.

2. Review of quality control measures and performance data.

3. Certification that the excavation support system is constructed per the applicable design following completion of each support system and following any modifications by CONTRACTOR during construction.

1.05 QUALITY ASSURANCE

A. Regulations: Perform work in accordance with current applicable regulations and codes of Federal, State and local agencies.

1.06 DESIGN REQUIREMENTS

A. The design of temporary excavation support systems is the responsibility of the CONTRACTOR. The design calculations and drawings shall be prepared, stamped and signed by a Professional Engineer registered in the State of California.

B. Design temporary excavation support systems in accordance with requirements of this Section. These criteria are the minimum acceptable standards.

C. Underground utility lines shall be identified, located, and protected from damage or displacement. Utility companies and other responsible authorities shall be contacted to locate and mark the locations and, if they so desire, direct or assist with protecting the underground installation. When required, the CONTRACTOR shall obtain an excavation permit from the local authority having jurisdiction prior to the initiation of any excavation work.

D. Design excavation support systems in accordance with OSHA requirements and other local and agency requirements.

E. Design the support system to minimize horizontal and vertical movements and to protect adjacent structures and utilities from damage.

F. Excavations below the level of the base of any adjacent foundation or retaining wall shall not be permitted unless the design of the excavation and bracing includes an analysis of the stability of the structure supported by the foundation and as necessary, incorporates required bracing/underpinning of the foundation.

G. For support systems in which bracing is installed between opposite sides of the excavation, design the excavation support of both sides to be nearly the same as feasible.

H. Where necessary to resist point loads, pipe piles used as soldier piles shall be filled with concrete with a compressive strength not less than 3,000 psi. The strength of the concrete shall not be considered in design of the pipe pile for bending stress.

I. Design, install, operate, and maintain ground water control system to control ground water inflows, prevent piping or loss of ground, and maintain stability of the excavation. Refer to the requirements of Section 02140.

J. Design review and field monitoring activities by the OWNER shall not relieve the CONTRACTOR of his/her responsibilities for the work.

PART 2 PRODUCTS

2.01 MATERIALS

A. Soldier piles and structural steel members shall conform to ASTM A572 or ASTM A242 unless approved otherwise. No members with permanent deformations are to be provided. Members shall not be spliced unless approved by the OWNER.

B. Steel sheet piling shall conform to ASTM A328 or ASTM A572 or ASTM A690, unless approved otherwise.

C. Liner plates shall be fabricated from structural quality hot-rolled carbon steel sheets or plates conforming to ASTM A1101 with the following minimum properties before cold forming:

1. Tensile Strength: 42,000 psi

2. Yield strength: 28,000 psi

Plates shall be of either the two- or four-flange type, punched for bolting on sides. Bolt spacing shall be in accordance with the manufacturer’s standard spacing and shall be multiples of the plate length so that the plates having the same curvature shall be interchangeable. Bolt numbers and pattern shall be determined by the liner supplier.

D. Concrete shall conform to ASTM C33 and ASTM C150 unless otherwise approved.

E. Timber shall be structural grade with a minimum allowable flexural strength of 1100 psi. Timber lagging shall be at least 3 inches thick and free of large or loose knots.

PART 3 EXECUTION

3.01 GENERAL

A. Commence installation of support system and excavations only after shop drawings have been reviewed and accepted by the OWNER.

B. Instrumentation required per Section 02445 shall be installed and initialized prior to the start of work.

C. Methods of construction for excavations shall be such as to ensure the safety of the Work, CONTRACTOR's employees, OWNER, and OWNER's employees and inspectors, the public and adjacent property and improvements, whether public or private.

D. Before beginning construction at any location of this project, adequately protect existing structures, utilities, trees, shrubs, and other existing facilities. The repair of or compensation for damage to existing facilities shall be at no additional cost to the OWNER.

E. As a minimum, place fencing, gates, lights, and signs as necessary around the excavations and staging areas to provide for public safety.

F. Install excavation support systems in accordance with the approved shop drawings and applicable permits.

G. Voids between excavation support system and earth shall be filled with materials acceptable to the OWNER.

H. If unstable material is encountered during excavation, necessary measures shall be taken immediately to contain it in place and prevent ground displacement.

I. If settlement or deflections of supports indicate that support system requires modification to prevent excessive movements, redesign and resubmit revised shop drawings and calculations to the OWNER at no additional cost.

J. Sufficient quantity of material shall be maintained on site for protection of work and for use in case of accident or emergency.

K. Welding shall conform to the applicable provisions of ANSI/AWS D1.1.

3.02 PORTABLE TRENCH BOXES

A. Portable trench boxes or sliding trench shields may be used for the protection of workers only.

B. Trench boxes shall not be used as tunnel launch and exit shafts.

C. Additional excavation, backfilling, and surface restoration required as the result of trench box use shall be at no additional cost to the OWNER.

D. Trench boxes or shields shall be designed, constructed, and maintained to meet acceptable engineering and industry standards.

E. Shields shall be installed in a manner to restrict lateral or other hazardous movement of the shield in the event of the application of sudden lateral loads.

F. A copy of the trench box manufacturer’s specifications, recommendations, and limitations shall be in written form and maintained at the job site during excavation work.

3.03 SOLDIER PILES

A. Install soldier piles with the minimum embedment depths as shown on approved shop drawings.

B. Soldier piles shall be installed using an impact hammer.

C. Driven piles shall be installed with driving shoes where hard driving is anticipated.

D. For soldier piles installed in predrilled holes, provide casing or other methods of support as necessary to prevent caving of holes and loss of ground.

E. Predrilled holes for soldier piles shall be backfilled with concrete from the pile tip elevation to the elevation of the bottom of the excavation. The remainder of the predrilled hole shall be backfilled with lean concrete or sand. Concrete strength shall be in accordance with the approved shop drawings.

F. The predrilled hole diameter shall be sufficient to allow for proper alignment and concrete backfilling of the pile.

G. Driven soldier piles shall be advanced without the aid of a water jet unless otherwise authorized.

H. Provide timber lagging of sufficient thickness to withstand earth pressures and in accordance with the approved shop drawings.

I. Install lagging such that ground loss does not occur between adjacent or below the lowest board. As excavation proceeds, the maximum height of unlagged face of excavation shall not exceed 4 feet. The unlagged face shall not exceed 2-ft if water seeps or flows from the face of the excavation or if the face of the excavation becomes unstable.

J. As installation progresses, backfill the voids between the excavation face and the lagging. Pack with materials such as hay, burlap, or geotextile filter fabric where necessary to allow drainage of ground water without loss of ground.

3.04 STEEL SHEET PILING

A. Install steel sheet piling with the minimum embedment depths as shown on the approved shop drawings.

B. Drive sheeting in plumb position with each sheet pile interlocked with adjoining piles for its entire length so as to form a continuous diaphragm throughout the length of each run of wall, bearing tightly against original ground. Exercise care in driving so that interlocking members can be extracted without damaging adjacent structures or utilities. The methods of driving, cutting, and splicing shall conform to the approved shop drawings.

C. Use templates or other temporary alignment facilities to maintain piling line.

D. Prior to installation, the sheet piles shall be thoroughly cleaned and inspected for defects and for proper interlock dimensions. The CONTRACTOR shall provide a tool for checking the interlock dimensions.

E. Each sheet pile shall have sufficient clearance in the interlocks to slide, under its own weight, into the interlock of the sheet pile previously placed.

F. Excavation shall not be carried in advance of steel sheet piling installation.

G. Obstructions encountered before the specified embedment for piles shall be removed. Where obstructions cannot be removed, the sheet pile system shall be re-evaluated by the CONTRACTOR's Design Engineer for the resulted reduced embedment and additional toe stability measure implemented, as required or for realignment of the sheet pile wall. A submittal of the proposed measures shall be provided.

H. Damaged piling or piling with faulty alignment shall be withdrawn and new piling driven properly in its place. The cost of such additional work shall be considered as part of the pile driving and shall be borne by the CONTRACTOR.

3.05 LINER PLATES

A. Liner plates shall be installed as soon as excavation has progressed sufficiently for the next ring of plates to be installed. A complete circumferential ring of liner plates shall be installed prior to continuing the excavation. Installing more than one incomplete ring of liner plates at any time is not acceptable. Plates shall be staggered in the vertical direction to facilitate shaft strength and leakage resistance.

B. Liner plates shall be grouted in accordance with the approved shop drawings.

3.06 INTERNAL BRACING

A. Provide internal bracing to carry maximum design load without distortion or buckling.

B. Include web stiffeners, plates, or angles as needed to prevent rotation, crippling, or buckling of connections and points of bearing between structural steel members. Allow for eccentricities caused by field fabrication and assembly.

C. Install and maintain bracing support members in tight contact with each other and with the surface being supported. Wood shims shall not be used.

D. Coordinate excavation work with installation of bracing. Excavation shall extend no more than 2 feet below any brace level prior to installation of the bracing.

E. Use procedures that produce uniform loading of bracing member without eccentricities or overstressing and distortion of members of system.

3.07 REMOVAL OF EXCAVATION SUPPORT

A. Do not remove internal bracing and transfer loads to the permanent structure without prior acceptance of the OWNER.

B. Removal shall begin at and progress from the bottom of the excavation. Members shall be released slowly as to note any indication of possible failure of the remaining members or possible cave-in of the sides of the excavation.

C. Backfilling shall progress together with the removal of support systems from excavations.

D. Unless otherwise indicated, remove buried portions of excavation support.

E. Do not remove vertical support members that were installed within the zone of influence of new or existing structures. The zone of influence is defined as a zone extending down and away from the outer edge of the structure at 1 horizontal to 1 vertical. Support members installed within this zone shall be cut off at 5 ft below finished grade and abandoned in place.

F. No untreated wood shall remain as part of the abandoned portion of the work.

G. When removing the excavation support system, do not disturb or damage adjacent buildings, structures, waterproofing material, or utilities. Fill voids immediately with lean concrete or well-graded cohesionless sand, as indicated or as directed by the OWNER.

H. Remove material of the excavation support system from the site immediately.

END OF SECTION

SECTION 02322

STEEL CASING PIPE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Installation of piping and appurtenances as shown on the Drawings and as specified herein.

B. Boring and jacking pits and equipment, sheeting, steel casing pipe, galvanized steel vent pipe, wooden skids, steel straps, masonry seals, coatings, location signs as required, miscellaneous appurtenances and restoration.

1.02 RELATED WORK

A. Trenching, Backfilling and Compaction in Section 02221.

B. High Density Polyethylene (HDPE) Pipe and Fittings in Section 02623.

C. Polyvinyl Chloride (PVC) Pressure Pipe in Section 02622.

D. Surface Preparation and Shop Painting is included in Section 09901.

1.03 SUBMITTALS

A. Submit shop drawings showing a sketch of the jacking pit locations and method proposed for boring and jacking the casing pipe. Submit recent certified mill test reports, the protective bituminous coating used and the method proposed to seal the ends of the casing.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM A139 - Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4-in and over).

B. American Welding Society (AWS)

C. American Water Works Association (AWWA)

1.05 QUALITY ASSURANCE

A. Pipe to be installed under this Contract may be inspected at the site of manufacture for compliance with this Section by an independent laboratory selected by the OWNER. The manufacturer's cooperation shall be required in these inspections. Any inspection requested by the OWNER of pipe approved for this Contract, plus the cost of inspection of a reasonable amount of disapproved pipe, will be borne by the OWNER.

B. Submit to the OWNER for approval, within 30 days after signing of the Contract, a listing, including materials to be furnished, the name of the suppliers, the date of delivery of materials to the job site and a time schedule for the completion of the project.

PART 2 PRODUCTS

2.01 STEEL CASING PIPE

A. Steel casings shall conform to the requirements of ASTM A139, Grade "B" and shall be protected inside and outside by a black bituminous coating minimum 5 mils thick. The casing pipes shall have the minimum nominal diameter and wall thickness as shown on the Drawings.

B. Field and shop welds of the casing pipes shall conform with the AWS Standards. Field welds shall be complete penetration, single-vee groove or single-bevel groove type joints.

2.02 SURFACE PREPARATION AND SHOP PAINTING

A. Ferrous surfaces of valves and appurtenances shall receive an exterior coating of rust-inhibitive primer as specified in Section 09901. Interior coatings shall be the manufacturer's standard except that valves on raw and potable water lines shall be coated with paints approved by both EPA and AWWA for potable water service. Pipe connection openings shall be capped after shop painting to prevent the entry of foreign matter prior to installation.

2.03 CASING INSULATORS

A. Factory made isolators/spacers capable of supporting the carrier pipe and electrically isolating it from the casing

B. Suitable for supporting weight of carrier pipe without deformation or collapse during installation.

C. Runner lubrication shall be environmentally safe and within manufacturer's recommendations.

D. Casing isolators/spacers shall have a minimum 14 gage steel band. Contractor shall design risers for loads, and as a minimum shall use 10 gage steel risers, except on bottom runners where steel risers shall be 7 gage minimum.

E. Steel band to have a polyvinyl chloride inner liner with a minimum thickness of 0.09 inch, a durometer "A" of 85-90 hardness, and a minimum dielectric strength of 58,000 volts.

F. The runners shall be a minimum of 2" in width and a minimum of 11" in length. Runners shall be attached to the band or riser by 3/8", minimum, welded steel studs. Runner studs and nuts shall be recessed well below the wearing surface of the runner, and recess shall be filled with a corrosion inhibiting filler.

G. Runners shall be pressure-molded glass reinforced polymer with a minimum compressive strength of 18,000 psi per ASTM D638. Polyethylene is not acceptable.

H. Steel riser height with attached runner to be sufficient to provide a minimum clearance of 2 inches between the outside of carrier pipe bells or couplings and the inside of the casing.

I. Manufacturers: PSI Products, Inc., Available from Pacific Pipeline Products, Lafayette, CA, (925) 284-1515; Advance Products & Systems, Inc. (337)-233-6116; or approved equal.

2.04 CASING GROUT

A. Grout used for backfilling the annular space between the carrier pipe and casing shall be in accordance with Section 02330.

B. The grouting equipment shall be provided with a meter to determine the volume of grout injected. The meter shall be calibrated in cubic feet to the nearest one-tenth of a cubic foot.

PART 3 EXECUTION

3.01 GENERAL

A. Care shall be taken in loading, transporting and unloading to prevent injury to the pipe or coatings. Pipe shall not be dropped. Pipe shall be examined before laying and no piece shall be installed which is found to be defective. Any damage to the pipe coatings shall be repaired as directed by the OWNER.

B. Pipe shall be subjected to a careful inspection prior to being installed. If the pipe fails to meet the specified requirements it shall be removed and replaced with a satisfactory replacement at no additional expense to the OWNER.

C. Tolerances for installation of the casing pipes shall be as follows:

1. Elevation - to grade or a maximum of 9-in below grade.

2. Plan Location – plus/minus 1-ft.

D. The carrier pipes shall be supported within the casing pipes so that the pipe bells do not rest directly on the casing. The load of the carrier pipes shall be distributed along the casing by the method of support shown on the Drawings.

E. Dewatering through the casing during construction will not be permitted. Dewatering methods shall be approved by the OWNER before work begins.

F. Work shall be performed in conformance with the requirements of the agency involved. Any special requirements of the agency such as insurance, flagmen, etc, shall be strictly adhered to during the performance of work on this project. The special requirements shall be performed at no additional cost to the OWNER.

G. Complete record information shall be obtained prior to backfilling the work.

3.02 GROUTING

A. Mixing of Grout: The material shall be mixed in equipment of sufficient size to provide the desired amount of grout material for each stage in a single operation. The equipment shall be capable of mixing the grout at the required densities for the approved procedure and shall be capable of changing the densities as required by field conditions.

B. Backfill Annular Space with Grout: After the installation of the carrier pipe, the remaining space (voids) between the casing and the carrier shall be filled in accordance with Section 02330 so surfaces of the exterior carrier pipe wall and casing interior are in contact with the grout. Grout shall be pumped through a pipe or hose. Use grout pipes, or other appropriate materials to avoid damage to carrier pipe during grouting.

C. Injection of Grout: The grout injection pressure shall not exceed the carrier pipe manufacturer's approved recommendations or 5 psi (whichever is lower). Pumping equipment shall be of a size sufficient to inject grout at a volume, velocity, and pressure compatible with the size/volume of the annular space. Once grouting operations begin, grouting shall proceed uninterrupted, unless grouting procedures require multiple stages. Grout placements shall not be terminated until the estimated annular volume of grout has been injected.

D. Block the carrier pipe during grouting to prevent flotation during grout installation. The Contractor shall also protect and preserve the interior surfaces of the casing from damage. It is the responsibility of the Contractor to submit to the OWNER sufficient information indicating proposed equipment, materials, and the method for filling this void.

END OF SECTION

SECTION 02330

TUNNEL GROUTING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Tunnel grouting.

1.02 RELATED WORK

A. Excavation Support and Protection is included in Section 02311.

1.03 SUBMITTALS

A. Submit proposed grout mixes, pressures, pumping rates and the sequence of drilling and grouting holes.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

2. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar.

3. ASTM C150 - Standard Specification for Portland Cement.

PART 2 PRODUCTS

2.01 MATERIALS

A. Cement shall conform to the requirements of ASTM C150, Type II.

B. Sand shall conform to ASTM C144, except as modified herein and shall consist of clean, hard, durable grains of approved inert materials. Sand shall be well graded to attain a fineness modulus between 1.50 and 2.00. It shall also meet the following requirement.

Sieve Sizes	Percentage Passing by Weight
No. 16	95
No. 200	Not More Than 5

C. Water shall be potable, clean and free from deleterious amounts of acids, alkalis, oils, or organic matter.

D. Grout admixtures may be used subject to the approval of the OWNER to improve pumpability, control time of set, hold sand in suspension, and to reduce segregation and bleeding.

E. Grout mixture proportions shall be such as to provide continuous efficient flow to fill spaces required to be filled.

F. Pipe and fittings shall conform to ASTM A53, Standard weight, Schedule 40, black.

G. Equipment

1. Either rotary of percussion drills may be used to drill grout and other holes. Equipment for mixing and injecting grout in continuous flow, at the required pressures and without particle segregation, shall be of an approved type and capacity and suitable for the appropriate placement methods and procedures. Furnish a standby grout pump at site.

PART 3 EXECUTION

3.01 GENERAL

A. Grouting shall be performed to fill voids and spaces outside the casing pipe, to control water flows and to consolidate ground.

3.02 GROUT PIPING

A. Grout pipe nipples shall be firmly fixed in position, wrapped in waxed paper to prevent bonding with the concrete lining and removed following completion of the grouting operation. Removable covers shall be attached to the ends of the grout pipe to prevent entry of concrete or other foreign materials prior to grouting. Grout holes shall be filled with stiff grout or dry packed at the completion of the grouting operation and the interior of the pipe restored to a smooth, even surface. Approved mechanical packers may be used for grout connection to drilled holes. Grout connections shall be provided with suitable pressure gauges, calibrated with a master gauge when required by the OWNER and with guide closing valves to maintain pressure until the grout has set.

B. Vent pipes shall be placed through the tunnel lining at high areas of the crown to provide for venting of entrapped air and water.

3.03 GROUTING

A. Pressure grouting shall be applied at the following locations:

1. At 10-ft intervals, staggered along each side of the pipe crown.

2. At locations where voids have occurred as a result of work of this Section.

B. Pressure for grouting shall be sufficient to assure the filling of voids but not damage the casing pipe. Damaged pipe shall be repaired or replaced, to the satisfaction of the OWNER, at no additional cost.

END OF SECTION

SECTION 02445

SETTLEMENT MONITORING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Installing surface control points, installing subsurface monitoring points, furnishing monitoring equipment, and recording observations and measurements from the monitoring points on a periodic basis before, during, and after trenchless construction, and trench excavation work.

B. The CONTRACTOR is responsible for surveying the elevations of the surface control points, the subsurface monitoring points, and other instrumentation locations in accordance with the requirements herein. Elevations shall be determined before operations begin to establish a baseline, and during and after operations to monitor any movements related to the tunneling and shaft construction. Monitoring points will be surveyed after trenchless construction has been completed to evaluate long-term settlements, as specified herein.

C. Minimum instrumentation requirements are specified herein. Additionally, the CONTRACTOR shall install other instrumentation as necessary to control operations, monitor ground conditions and ground response to achieve specified project requirements and to prevent damage to existing structures and facilities.

1.02 RELATED WORK

A. Work in a Railroad Property in Section 02450.

B. Steel Casing Pipe in Section 02322.

C. Tunnel and Shaft Grouting in Section 02330.

D. Jacking in Section 02151.

E. Horizontal Directional Drilling in Section 02158.

1.03 DEFINITIONS

A. Surface Control Points: Control points established as a reference for measuring elevation of the ground surface using optical survey methods.

B. Subsurface Monitoring Point: A cased borehole settlement monitoring point located above the tunnel crown used for detecting settlement between the location of the settlement point and the tunnel excavation.

1.04 DESIGN CRITERIA

A. Any ground movements (settlement/heave) shall be limited to values that shall not cause damage to adjacent utilities and facilities. In no case shall settlements exceed the applicable values listed in Table 1 below.

Table 1 - Allowable Settlement / Heave Values

Site Feature	Allowable Settlement/ Heave (inches)
Railroads	0.25
Surface Streets	1.00
Underground Utilities	1.00
Unimproved Ground	3.00

1.05 QUALITY ASSURANCE

A. Install monitoring points and instrumentation within one-half (0.5) foot of the horizontal and vertical location shown on the Plans or as directed by the OWNER. Other surface control points shall be installed as directed by the OWNER.

B. Should actual field conditions prevent installation of instruments at the location shown on the Plans or specified herein, obtain written acceptance from the OWNER for new instrument location and elevation.

C. Surveying for monitoring settlement instrumentation shall be referenced to the same control points and benchmarks established for setting out the Work. Control points shall be tied to benchmarks and other monuments outside of the zone of influence of the excavation or trenchless construction.

D. Installation of instrumentation shall be performed in the presence of the OWNER.

1.06 SUBMITTALS

A. Qualifications: Submit surveying personnel qualifications in accordance with the requirements herein.

B. Submit the following, at least one (1) month before scheduled installation of monitoring points:

1. Instrumentation Schedule: Submit the proposed schedule for installing the surface control points and subsurface monitoring points.

2. Description of methods and materials for installing and protecting surface control points and subsurface monitoring points.

3. Drawings with locations of proposed monitoring points shown in plan and profile.

C. Reports and Records:

1. The CONTRACTOR shall submit reports of monitoring data to the OWNER.

2. Within 72 hours following installation of the instruments, submit drawings showing the actual as-built installed location, the instrument identification number, the instrument type, the installation date and time, and the tip elevation and instrument length. Include details of installed instruments, accessories and protective measures including dimensions and materials used.

3. Submit surveyed baseline measurements of monitoring points at least fourteen (14) days prior to commencing excavation to establish baseline readings.

4. Submit surveyed measurements of monitoring points during and after construction in accordance with Part 3 of this Specification.

PART 2 PRODUCTS

2.01 MATERIALS

A. Instrumentation shall remain the property of the CONTRACTOR following completion of the Work, and shall be removed or abandoned according to applicable codes and standards unless otherwise noted.

B. Surface Control Points: Surface control points shall be established by an inscribed marking or approved surveyor's nail driven flush with the surface in asphalt or concrete paved areas. In landscaped areas, surface control points shall be established by driving a 2-inch by 2-inch timber stake flush with the ground. The stake shall be driven to a depth required to provide a stable control point given the soil conditions. Each control point shall have a tag or marking indicating the station and offset from centerline.

C. Subsurface Monitoring Points: Subsurface monitoring points shall be established and installed as indicated on the Drawings. Each point shall consist of a #6 rebar settlement rod installed within and isolated from a PVC cased borehole. The settlement rod shall be driven 6 to 12 inches past the bottom of the borehole casing and the tips shall be located at five feet above the pipe crown centerline as noted on the Drawings, or as directed by the OWNER. The settlement rod shall be secured to the PVC casing with a 12-inch length of loose cable or chain to prevent the rod from falling more than approximately 12 inches. The casing shall be flush with pavement or recessed, and capped and protected with a road box if installed within traffic lanes, shoulders, parking lots, or bike lanes and shall be in accordance with CalTrans and other applicable permit requirements.

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. Instrumentation shall be installed at the locations shown on the Drawings, and as approved by the OWNER. Instruments shall be installed in accordance with the approved installation schedule.

B. The CONTRACTOR shall locate conduits and underground utilities in areas where borings are to be drilled and instruments installed. Instrument locations shall be modified, as approved by the OWNER, to avoid interference with the existing conduit and utilities. Repair damage to existing utilities resulting from instrument installations at no additional cost to the OWNER.

C. CONTRACTOR shall install and perform a baseline survey of surface and subsurface settlement monitoring devices at least 14 days prior to excavation.

D. CONTRACTOR shall provide access and assistance to the OWNER for obtaining supplemental monitoring data, as requested.

E. Provide data from readings of monitoring points to the OWNER within 24 hours of reading.

3.02 MONITORING FREQUENCY

A. Surface Control Points: Initial survey measurements shall be obtained prior to any excavation and at two-day intervals after beginning excavation or trenchless operations.

B. Subsurface Monitoring Points: Once trenchless operations begin, subsurface monitoring points within 50 feet of the tunnel face shall be surveyed once for every 10 feet of tunnel progress. Additionally, monitoring points shall be surveyed at least once per day during trenchless operations. Once these operations are complete, settlement monitoring devices shall be surveyed once per day for the first seven days, once at 14 days, and once at 30 days after completion of the trenchless work.

3.03 SURFACE CONTROL POINTS

A. Establish a system of surface control points. Some control point locations are shown on the Drawings, and the locations of the remainder shall be determined jointly by the OWNER and CONTRACTOR in the field prior to construction.

B. Surveying of surface control points will consist of determining the elevation of each control point with respect to a benchmark selected by the OWNER to a precision of 0.01 foot.

3.04 SUBSURFACE MONITORING POINTS

A. Notify the OWNER at least three days in advance of installing subsurface monitoring points.

B. The subsurface monitoring points shall be installed as close as practicable to the locations shown on the Drawings. The OWNER may modify subsurface monitoring point locations depending on field conditions, conflicting utilities and monitoring objectives.

C. Locate and confirm utilities and protect utilities or relocate monitoring points as necessary to protect utilities. Follow accepted industry procedures for one-call notification and visual confirmation of locations of crossing or adjacent utilities.

D. Subsurface monitoring point installations shall be completed at least 14 days in advance of commencing shaft construction operations.

E. Conduct drilling operations using appropriate methods that are consistent with anticipated geologic conditions. Use mud rotary wash methods or provide casing as required to hold drill hole open.

F. Subsurface monitoring rods shall move freely with the soil at the tip and shall be isolated from the soil surrounding the borehole by the casing.

G. Protection: Install protective housing with cap. Protective housing shall be installed within a flush-mounted precast concrete box or vault so as not to obstruct vehicle or foot traffic, and shall be in accordance with CalTrans standards and permit requirements.

3.05 INSTRUMENT PROTECTION, MAINTENANCE, AND REPAIR

A. Protect the instruments and surface control points from damage. Damaged installations shall be replaced or repaired prior to continuing excavation, pipe jacking, or HDD, unless permitted otherwise in writing by the OWNER.

3.06 ABANDONMENT OF INSTRUMENTS

A. Surface Control Points: Surface control points on public property shall remain in place at the completion of the Work. Remove surface control points on private property during the cleanup and restoration work, or as required by the OWNER.

B. Subsurface monitoring points: Properly abandon monitoring point boreholes, by grouting drilled holes with neat cement grout. Subsurface monitoring points shall be abandoned at the conclusion of the monitoring phase (See Section 3.2 B) or as required by the OWNER.

END OF SECTION

SECTION 02450

WORK IN RAILROAD PROPERTY

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Installation of the recycled water in the locations as shown on the Drawings and as specified herein. As shown on the Drawings some of the new recycled water pipeline is to be installed within the right-of-way of the Sonoma Marin Area Rail Transit District (SMART).

1.02 OPERATIONS ON RAILROAD PROPERTY

A. Work on this project affecting the SMART property, right-of-way, or facilities shall be carried out to the full satisfaction of the Railroad's Chief Engineering Officer, or his/her authorized representative. Review requirements of the SMART as it pertains to the specific project work accordingly.

B. Make necessary arrangements with the Railroad before entering upon railroad premises.

C. Prior to the start of work, furnish, at no expense to the Railroad, Workmen's Compensation, Public Liability and Property Damage and Protective Insurance, copies of which shall be furnished to the Railroad's Chief Engineering Officer and the OWNER.

D. The policies shall be in force before any work is done in the vicinity of the Railroad and shall remain in effect until work required to be performed under the terms of the Contract is satisfactorily completed as evidenced by the formal acceptance.

E. The insurance shall be provided with the SMART insured in the following amounts: Public Liability of $2,000,000, Property Damage Liability of $2,000,000. The insurance shall be Oregon Type with endorsement to include coverage of sole negligence of the Railroad.

F. The Chief Engineering Officer of the Railroad and the OWNER are to be furnished a copy of the General Liability Policies at least 7 days prior to commencement of the work or the location of any equipment on Railroad property.

G. No changes or alterations in the policies shall be made without the approval of the Chief Engineering Officer.

H. An advance deposit to the Railroad is required. Prior to the start of any work on the railroad right-of-way, consult with the Railroad for review of the operators by the Chief Engineer. Upon completion of this review, the Railroad will advise of the deposit required. If the Railroad expenses are greater than the amount of the deposit, reimburse the Railroad for the balance when billed and if the Railroad expenses are less than the amount of the deposit, the Railroad will refund the balance. The Railroad will provide, at its sole discretion, such personnel as it deems necessary or advisable because of the project. Work and/or services performed by the Railroad shall be paid for by the CONTRACTOR. The Railroad reserves the right to request additional deposits as project work progresses.

I. Prior to the start of work, an outline of the methods to be used for construction and a time schedule for operations shall be submitted to the Railroad and the OWNER for approval and no work shall be done until approval is given by the Railroad.

J. SMART is currently training Roadway Workers Protection and Employee in Charge online, available 24 hours a day, 7 days a week. Prior to the start of work, persons requesting access to SMART property must have proper training. The training website is http://www.contractororientation.com/. Instructions are as follows:

1. Register CONTRACTOR company information.
2. Contractor Orientation website will return a login password to allow access to the website.
3. Once logged in, click on the available railroad courses and reference material.
4. Click on SMART (EIC) training site.
5. Smart EIC Course Password is SMART
6. Click on SMART EIC Course to begin training.

All reference material must be either copied or downloaded from the site and must be made available while on SMART property.

K. Three days written notice prior to start of the actual work shall be given the Railroad with a copy to the OWNER.

L. Conduct the work so that schedules, trains and speeds can be maintained on the Railroad. The safety and continuous operation of the Railroad is of primary importance and shall be safeguarded.

M. Install, maintain and remove any sheeting, underpinning, and cribbing to support any structure or facility on the right-of-way owned by the SMART. The Railroad or the OWNER, depending upon existing conditions, may require that sheeting be left in place.

N. In no instance shall any wires, equipment or other appurtenances be placed across or pass across Railroad property without the express written permission of the Chief Engineering Officer.

O. Railroad inspection of the work shall always be permitted and full cooperation with Railroad representatives will be required.

P. Equipment used on Railroad property may be inspected by the Railroad and shall not be used if considered unsatisfactory by Railroad representatives. Operators of such equipment may be examined by Railroad representatives to determine their fitness. The Railroad tracks shall be kept free of obstructions.

Q. No blasting will be permitted under or adjacent to the tracks.

R. No claims for any delays in completion time due to Railroad causes if the requirements set forth in this specification are not complied with immediately by the CONTRACTOR.

S. Be fully responsible for damages arising from the failure to comply with the regulations and the requirements of this Section.

T. Work within the railroad right-of-way shall be performed and completed in a manner fully satisfactory to the Railroad's Chief Engineering Officer or his/her authorized representative.

END OF SECTION

SECTION 02576

PAVEMENT REPAIR AND RESURFACING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Replacement of pavement removed over trenches or otherwise disturbed by the CONTRACTOR's operations.

B. New pavement in streets shall consist of initial pavement over trenches and final bituminous concrete pavement placed either over trenches or over the entire paved traveled way as directed by the OWNER or as shown on the drawings.

C. Streets, driveways, parking areas or sidewalk pavements damaged or disturbed by the CONTRACTOR's operations shall be repaired, replaced or restored in accordance with the requirements specified herein and as directed for the respective type of pavement replacement and in a manner satisfactory to the OWNER.

D. Furnish labor, material, equipment and incidentals required to cold plane where directed by the OWNER.

1.02 RELATED WORK

A. Trimming edges of existing pavement is included in Section 02221.

1.03 REFERENCE STANDARDS

A. Except as otherwise specified herein, the current Standard Specifications for Highways and Bridges, including addenda, issued by the California Department of Transportation (Caltrans), shall apply to materials and workmanship required for the work of this Section.

B. American Association of State Highways and Transportation Officials (AASHTO)

1. AASHTO M144 - Standard Specification for Calcium Chloride.

1.04 MAINTENANCE

A. Pavement placed shall be maintained for a period of 1 year. During this period areas which have settled or are unsatisfactory for traffic shall be refilled and replaced.

PART 2 PRODUCTS

2.01 MATERIALS

A. Calcium chloride shall conform to AASHTO M144, Type I or Type II.

B. Initial pavement shall be Binder Course, conforming to the referenced standard, Section M3.11, Class I, Type I-1 bituminous concrete.

C. Final trench pavement shall consist of Binder Course and Top Course, conforming to the referenced standard, Section M3.11, Class I, bituminous concrete.

D. Final full width pavement shall be Top Course conforming to the referenced standard, Section M3.11, Class I, Type I-1, bituminous concrete.

PART 3 EXECUTION

3.01 GENERAL

A. Materials for pavement shall be mixed, delivered, placed and compacted in accordance with the referenced standard, Sections M3.11 and 460 and as specified herein.

B. Whenever the subbase becomes dry enough to cause dust problems, spread calcium chloride uniformly over the gravel surface in sufficient quantity to eliminate the dust.

C. When the air temperature falls below 50 degrees F, extra precautions shall be taken in drying the aggregates, controlling the temperatures of the materials and placing and compacting the mixtures.

D. No mixtures shall be placed when the air temperature is below 40 degrees F, nor when the material on which the mixtures are to be placed contains frost or has a surface temperature not suitable to the OWNER.

E. No vehicular traffic or loads shall be permitted on the newly completed pavement until adequate stability has been attained and the material has cooled sufficiently to prevent distortion or loss of fines. If the climatic or other conditions warrant it, the period of time before opening to traffic may be extended at the discretion of the OWNER.

3.02 INSTALLATION

A. Initial pavement shall be placed wherever existing pavement has been removed or disturbed as soon as practical, but in no case more than 1 week after backfilling is completed.

1. The bank run gravel subbase shall be excavated to a depth of 2-in below the existing pavement, shaped and compacted.

2. The 2-in initial pavement shall be placed and compacted by steel-wheeled rollers of sufficient weight to thoroughly compact the bituminous concrete without damaging the existing pavement. The new pavement shall be rolled smooth and even with the existing pavement.

3. Hose clean road surfaces adjacent to the trench area to be paved. No paving is to be placed until subsurface is dry.

4. Initial pavement shall be maintained in a condition suitable for traffic until replaced or overlaid by final pavement. Defects shall be repaired within 3 days of notification of such defects.

B. Final pavement shall not be placed over trenches in less than 90 days after completion of the backfilling unless otherwise directed in writing by the OWNER.

C. Final pavement over trenches shall be constructed as follows:

1. Remove initial pavement and subbase to 3-in below existing pavement. Shape and compact subbase to 92 percent of maximum dry density as determined by ASTM D1557, Method D or by CTM 216.

2. Trim loose edges of existing pavement. Broom and tack coat edges with emulsified or cutback asphalt.

3. Place Binder Course and compact to 1-1/2-in thickness by steel-wheeled roller.

4. Broom and tack coat edges of existing pavement and Binder Course with emulsified or cutback asphalt.

5. Place Top Course and compact to 1-1/2-in thickness, finish smooth, dense and flush with surface of existing pavement.

D. Final pavement over the entire paved traveled way shall be constructed as follows:

1. Repair soft and broken areas in temporary and existing pavement. Remove cold patch which has been placed. Clean surfaces to be paved of foreign matter and loose material. Surfaces shall be dry before priming.

2. Raise manhole, drop inlet and catch basin frames, gate valve and curb stop boxes, gas drips and valves and any other pavement penetrations to finished elevation of the new pavement. Raised appurtenances shall be grouted with concrete or otherwise as approved by the OWNER to firmly support them flush with the surface of the new pavement.

3. Where required, level depressions in the initial pavement with bituminous material approved by the OWNER.

4. Repair any defects in curbing caused by the CONTRACTOR's operations.

5. Apply prime coat to existing and initial pavement.

6. Spread and compact Top Course to 1-1/2-in thickness over existing pavement to the entire width of the pavement. Bituminous concrete shall be placed by mechanical spreader except in areas inaccessible to the spreader.

7. Wherever the edge of the new pavement passes over existing paved driveways or side streets, or the new pavement ends on existing pavement, the existing pavement shall be grooved 1-in deep in the surface such that the surface of the new pavement will slope to the surface of the existing pavement in not less than 18-in and the new pavement will not be less than 1-in thick.

8. Clean pavement penetrations and remove loose aggregate from the site.

E. Cold planing shall be performed as follows:

1. In areas directed by the OWNER, remove up to 12-in of bituminous concrete using a cold planer. The planing machine shall be specifically designed and built for planing flexible pavements and have the ability to plane concrete patches when encountered in bituminous pavement.

2. The planing machine shall be self-propelled and have the means for planing without tearing or gouging the underlaying surface and blading the cutting into a window. The machine shall be capable of being operated at speeds from 10 to 40 fpm and designed such that the operator can observe the planning operation without leaving the control area. A cut to predetermined grade or any specified lesser depth up to the thickness specified in Paragraph 3.02E1 above may be required. The machine shall be adjustable as to crown and depth.

3. Manhole/catch basin covers and grates and other items at the roadway surfaces shall be lowered to a sufficient depth prior to cold planing. Damaged covers, grates and utility boxes shall be replaced with new covers, grates or utility boxes by the CONTRACTOR, at his/her expense.

4. The equipment furnished shall be maintained so as to produce a clean cut in the pavement.

5. The planed surface shall conform generally to the grade and cross slope required and be free from being torn, gouged, shaved, broken or excessively grooved.

6. Surface texture shall be as specified by the OWNER and in any case be acceptable to traffic in the event resurfacing is delayed. The planing shall be squared off for the full width of the traveled way at the end of each work day.

7. No cutting shall remain on the project at the end of each work day. Dispose of waste materials at no additional compensation.

8. The planed surface shall be free of imperfections of workmanship that will prevent the surface from being resurfaced with new pavement following this operation.

3.03 PAVEMENT MARKINGS

A. Reline streets with pavement markings equal in type and location where existing prior to paving.

END OF SECTION

SECTION 02605

PRECAST CONCRETE STUCTURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Installation of precast concrete manholes, frames and covers, frames and grates, and appurtenances.

1.02 RELATED WORK

A. Trenching, backfilling, and compaction are included in Section 02221.

1.03 SUBMITTALS

A. Submit shop drawings, product data, materials and details of construction, reinforcing and joints. Submittals shall include at least the following:

1. Base sections, riser sections, eccentric and concentric conical top sections, flat slab tops, grade rings with notarized certificate indicating compliance with ASTM C478.

2. Pipe connections to manholes.

3. Manhole frame and cover with notarized certificate indicating compliance with the specified ASTM standard and Class designation.

4. Method of repair for minor damage to precast concrete sections.

B. Design Data

1. Precast concrete structures:

a. Sectional plans and elevations showing dimensions and reinforcing steel placement.

b. Structural calculations including assumptions.

c. Concrete design mix.

C. Test Reports

1. Precast concrete structures:

a. Concrete test cylinder reports from an approved testing laboratory certifying conformance with this Section.

2. Results of leakage tests.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM A48 - Standard Specification for Gray Iron Castings.

2. ASTM C33 - Standard Specification for Concrete Aggregates.

3. ASTM C150 - Standard Specification for Portland Cement

4. ASTM C207 - Standard Specification for Hydrated Lime for Masonry Purposes

5. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections

6. ASTM C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections using Preformed Flexible Joint Sealant.

7. ASTM D4101 - Standard Specification for Propylene Plastic Injection and Extrusion Materials

B. American Concrete Institute (ACI)

1. ACI 318 - Building Code Requirements for Structural Concrete

2. ACI 350 - Code Requirements for Environmental Engineering Concrete Structures

C. American Association of State Highway and Transportation Officials (AASHTO)

1. Standard Specifications for Highway Bridges

D. Occupational Safety and Health Administration (OSHA)

1.05 QUALITY ASSURANCE

A. Material shall be new and unused.

B. Materials' quality, manufacturing process and finished sections are subject to inspection and approval by OWNER. Inspection may be made at place of manufacture, at work site following delivery, or both.

C. Materials will be examined for compliance with ASTM standards, this Section and approved manufacturer's drawings. Additional inspection criteria shall include: appearance, dimensions, blisters, cracks and soundness.

D. Materials shall be rejected for failure to meet any requirements specified herein. Rejection may occur at place of manufacture, at work site, or following installation. Recycled Water manhole precast concrete sections will be manufactured using the “wet method” of fabrication. Mark for identification rejected materials and remove from work site immediately. Rejected materials shall be replaced at no cost to OWNER.

E. Repair minor damage to precast concrete sections by approved method, if repair is authorized by OWNER. Epoxy mortar may be utilized for repairs subject to the approval of the OWNER.

PART 2 PRODUCTS

2.01 GENERAL

A. Like items of materials/equipment shall be the end products of one manufacturer in order to provide standardization for appearance, operation, maintenance, spare parts and manufacturer's service.

B. Provide lifting lugs or holes in each precast section for proper handling.

C. Cement shall conform to ASTM C150, Type II cement or equal.

D. Precast concrete sections shall be properly cured prior to shipping. Precast concrete sections shall not be shipped before concrete has attained 3,000 psi compressive strength.

E. Mark date of manufacture, name and trademark of manufacturer on the inside of each precast section.

2.02 PRECAST CONCRETE MANHOLE SECTIONS

A. Precast concrete base sections, riser sections, transition top sections, flat slab tops and grade rings shall conform to ASTM C478 and meet the following requirements:

1. Design precast concrete base and flat slab top for their own weight, weight of soil at 130 pcf, and a live load equal to AASHTO H-20 truck loading applied at finished grade.

2. Bottom slab thickness shall be no less than the riser wall thickness.

3. Construct precast concrete bases as shown on the Drawings.

4. Base, riser and transition top sections shall have tongue and groove joints.

5. Top section shall be eccentric cone where cover over pipe exceeds 4-ft. Top section shall be a flat slab where cover over top of pipe is 4-ft or less. Top section shall be a plastic lined flat slab where manhole riser sections are to be plastic lined.

6. Provide integrally cast knock-out panels in precast concrete manhole sections at locations, and with sizes shown on Drawings. Knock-out panels shall have no steel reinforcing.

2.03 MANHOLE FRAME AND COVER

A. Manhole frames and covers shall be of good quality, strong, tough, even grained cast iron, smooth, free from scale, lumps, blisters, sand holes and defects of any kind which render them unfit for the service for which they are intended. Manhole covers and frame seats shall be machined to a true surface. Castings shall be thoroughly cleaned and subject to hammer inspection. Cast iron shall conform to ASTM A48, Class 30.

B. Manhole covers on new recycled water manholes shall have a 36-in. clear opening and a diamond pattern, blind pick holes, the words “RECYLED WATER” cast in 3-in letters and “SVCSD” and “2012” cast in 1-5/8-in letters.

C. Replacement manhole covers for existing manholes shall have a 30-in. clear opening and a diamond pattern, blind pick holes, the words RECYLED WATER cast in 3-in letters and "SVCSD" cast in 1-5/8-in letters.

D. Manhole frames and covers shall be Neenah Foundry, East Jordan Iron Works, Inc., Campbell Foundry Company, or equal.

2.04 JOINTING PRECAST MANHOLE SECTIONS

A. Seal tongue and groove joints of precast manhole sections with either rubber O-ring gasket or preformed flexible joint sealant. O-ring gasket shall conform to ASTM C443. Preformed flexible joint sealant shall be Kent Seal No. 2 by Hamilton-Kent; Ram-Nek by K.T. Snyder Company or equal.

B. Completed joint shall withstand 15 psi internal water pressure without leakage or displacement of gasket or sealant.

2.05 PIPE PENETRATIONS TO MANHOLES

A. Connect pipe to manholes in the following ways:

1. Flexible sleeve - Integrally cast sleeve in precast manhole section or install sleeve in a formed or cored opening. Fasten pipe in sleeve with stainless steel clamp(s). Coat stainless steel clamp(s) with bituminous material to protect from corrosion. Flexible sleeve shall be Lock Joint Flexible Manhole Sleeve; Kor-N-Seal connector; PRX Press-Seal Gasket or equal.

2. Compression gasket - Integrally cast compression gasket in precast manhole section. Insert pipe into compression gasket. Compression gasket shall be A-Lok or equal.

2.06 DAMPPROOFING

A. Two coats of bituminous waterproofing material applied to the exterior surfaces of the manholes by brush or spray and in accordance with the manufacturer's recommendations. Dampproofing shall be Hydrocide 648 by Sonneborn Building Products; Dehydratine 4 by A.C. Horn Inc; RIW Marine Liquid by Toch Brothers or equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Manhole Installation.

1. Manholes shall be constructed to the dimensions shown on the Drawings and as specified herein. Protect work against flooding and floatation.

2. Place manhole base on a bed of 12-in crushed stone as shown on the Drawings. Set manhole base grade so that a maximum grade adjustment of 12-in is required to bring the manhole frame and cover to final grade.

a. Use precast concrete grade rings or brick and non-shrink mortar to adjust manhole frame and cover to final grade.

3. Set precast concrete barrel sections plumb with a 1/4-in maximum out of plumb tolerance allowed. Seal joints of precast barrel sections with either a rubber O-ring set in a recess or preformed flexible joint sealant in sufficient quantity to fill 75 percent of the joint cavity. Fill the outside and inside joint with non-shrink mortar and finished flush with the adjoining surfaces. Caulk the inside of any leaking barrel section joint with lead wool or non-shrink grout to the satisfaction of the OWNER.

4. Allow joints to set for 14 hours before backfilling unless the OWNER specifically approves a shorter period.

5. Plug holes in the concrete barrel sections required for handling with a non-shrinking grout or non-shrinking grout in combination with concrete plugs. Finish flush on the inside.

6. Backfill carefully and evenly around manhole sections.

B. Manhole Pipe Connections

1. Construct manhole pipe connections, including pipe stubs, as specified herein. Close or seal pipe stubs for future connections with a gasketed watertight plug.

C. Setting Manhole Frame and Cover

1. Set manhole covers and frames in a full mortar bed. Utilize bricks or precast concrete grade rings, a maximum of 12-in thick, to assure frame and cover are set to the finished grade. Set manhole frame and cover to final grade prior to placement of permanent paving. Install curb inlet stones as shown on the Drawings.

D. Dampproofing

1. Paint outer surfaces of precast manholes with two coats of bituminous dampproofing at the rate of 30 to 60 sq ft per gallon, in accordance with manufacturer's instructions.

3.02 LEAKAGE TESTS

A. Test each manhole for leakage. OWNER shall observe each test. Perform exfiltration test as described below:

B. Assemble manhole in place; fill and point lifting holes and exterior joints within 6-ft of the ground surface with an approved non-shrinking mortar. Test prior to placing the shelf and invert and before filling and pointing the horizontal joints below 6-ft of depth. Lower ground water table below bottom of the manhole for the duration of the test. Plug pipes and other openings into the manhole and brace to prevent blow out.

C. Fill manhole with water to the top of the cone section. If the excavation has not been backfilled and no water is observed moving down the surface of the manhole, the manhole is satisfactorily watertight. If the test, as described above is unsatisfactory as determined by the OWNER, or if the manhole excavation has been backfilled, continue the test. A period of time may be permitted to allow for absorption. Following this period, refill manhole to the top of the cone, if necessary and allow at least 8 hours to pass. At the end of the test period, refill the manhole to the top of the cone again, measuring the volume of water added. Extrapolate the refill amount to a 24-hour leakage rate. The leakage for each manhole shall not exceed one gallon

per vertical foot for a 24-hour period. If the manhole fails this requirement, but the leakage does not exceed three gallons per vertical foot per day, repairs by approved methods may be made as directed by the OWNER. If leakage due to a defective section of joint exceeds three gallons per vertical foot per day, the manhole shall be rejected. Uncover the rejected manhole as necessary and to disassemble, reconstruct or replace it as directed by the OWNER. Retest the manhole and, if satisfactory, fill and paint the interior joints.

D. No adjustment in the leakage allowance will be made for unknown causes such as leaking plugs, absorptions. It will be assumed that loss of water during the test is a result of leaks through the joints or through the concrete.

E. An infiltration test may be substituted for an exfiltration test if the ground water table is above the highest joint in the manhole. If there is no leakage into the manhole as determined by the OWNER, the manhole will be considered watertight. If the OWNER is not satisfied, testing shall be performed as previously described.

F. A vacuum test may be substituted for a leakage test as follows:

1. Where the excavation has not been backfilled, the filling and pointing of exterior joints shall not be necessary prior to performing this test.

2. The vacuum test shall be conducted as follows:

a. The compression band shall be inflated to affect a seal between the vacuum base and the top of the manhole. The vacuum pump shall then be connected to the outlet port with the valve open and a vacuum of 10" Hg (20" of Hg absolute) drawn. The valve shall then be closed.

b. The following test criteria shall apply to 4-ft and 5-ft diameter manholes:

(1) A drop of 1" Hg shall be allowed over a 2-minute period for manholes 0-10 feet deep.

(2) A drop of 1" Hg shall be allowed over a 2-1/2-minute period for manholes 10-15 feet deep.

(3) A drop of 1" Hg shall be allowed over a 3-minute period for manholes 15-30 feet deep.

(4) If the pressure drop exceeds the acceptable limits the CONTRACTOR shall be allowed to make necessary repairs, as approved by the OWNER. The manhole shall then be re-tested.

(5) If the manhole fails to meet the minimum requirements of the vacuum test when re-tested, it may be water tested as outlined in paragraph 3.02.

(6) Upon completion of a successful vacuum test, the interior and exterior joints shall be filled and pointed.

3.03 CLEANING

A. Thoroughly clean new manholes of silt, debris and foreign matter of any kind, prior to final inspections.

END OF SECTION

SECTION 02616

DUCTILE IRON PIPE AND FITTINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Installation, disinfection and testing of ductile iron fittings for piping.

B. Fittings shall be located substantially as shown on the Drawings. The OWNER reserves the right to make such modifications in locations as may be found desirable to avoid interference between pipes or for other reasons. Pipe fitting notation is for the CONTRACTOR's convenience and does not relieve him/her from installing and jointing different or additional items where required to achieve a complete piping system.

C. Where the word "pipe" is used it shall refer to pipe, fittings, or appurtenances unless otherwise noted.

1.02 RELATED WORK

A. Jacking is included in Section 02151.

B. Trenching, Backfilling and Compaction is included in Section 02221.

C. Earthwork is included in Section 02200.

D. Sedimentation and Erosion Control is included in Section 02270.

E. Pavement Repair and Resurfacing is included in Section 02576.

F. Valves and Appurtenances are included in Section 02640.

G. Corrosion Monitoring is included in Section 13111.

1.03 SUBMITTALS

A. Submit shop drawings and product data, including piping layouts, design calculations, warranty information, test reports.

B. Submit design calculations in accordance with Paragraph 2.02 below signed by a Professional Engineer.

C. Submit the name of the pipe and fitting suppliers and a list of materials to be furnished.

D. Prior to shipment of pipe, certified copies of mill tests confirming the type of materials used in the pipe, and shop testing of pipe to show compliance with the requirements of the applicable standards, along with a sworn affidavit of compliance that the pipe complies with the referenced standards, shall be submitted.

E. Submit copies of shop tests, including hydrostatic tests.

F. Submit information on all warranties.

G. Submit shop drawings with a tabulated laying schedule which references stations and invert elevations as shown on the Drawings as well as fittings, bends, outlets, restrained joints, tees, special deflection bells, adapters, solid sleeves and specials, along with the manufacturer's drawings and specifications providing complete details of items. The laying schedule shall show pipe class, class coding, station limits and transition stations for various pipe classes. The above shall be submitted to the OWNER for approval before manufacture and shipment. The location of pipes shall conform to the locations indicated on the Drawings. Full length pipe may be supplied from inventory provided that specification requirements are met. Shop drawings shall include but not be limited to:

1. Complete and dimensional working drawings of pipe layouts, including pipe stationing, invert elevation at changes in grade or horizontal alignment, elements of curves and bends both in horizontal alignment and vertical position.

2. The grade of material; size, wall thickness, of the pipe and fittings and appurtenances, type and location of fittings, specials, and valves; and the type and limits of the lining, lining reinforcing and coating systems of the pipe and fittings. Methods and procedures recommended by the coating manufacturer will be documented.

3. Joint details; methods and locations of supports,; and complete information concerning type, size and location of welds. Shop welds (no field welding will be allowed) will be clearly differentiated and welds will be clearly detailed with preparation procedures for pipe and parent material comprising each weld. Critical welding procedures will be identified along with methods for controlling welding stresses and distortions. Locations and proposed joint details will also be clearly identified.

4. Method of manufacture of pipe fittings; and any specials.

5. Other pertinent information for items to be furnished; product data to show compliance of couplings, supports, fittings, coatings and related items.

H. Submit anticipated production and delivery schedule.

I. Prior to shipment of pipe, submit a certified affidavit of compliance from the manufacturer stating that the pipe, fittings, gaskets, linings and exterior coatings for this project have been manufactured and tested in accordance with AWWA and ASTM standards and requirements specified herein.

J. Submit handling procedures for phases from finished fabrication through delivery including storage, transportation, loading, and unloading. This will include storage at the project site and required protection following installation prior to startup.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.

2. ASTM A194 - Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service.

3. ASTM A242 – Standard Specification for High-Strength Low-Allow Structural Steel

4. ASTM A307 – Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

5. ASTM C150 - Standard Specification for Portland Cement.

B. American Water Works Association (AWWA)

1. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.

2. AWWA C110 - Ductile-Iron and Gray-Iron Fittings, 3-in through 48-in (75mm Through 1219mm) for Water.

3. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

4. AWWA C116 – Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior surfaces of Ductile Iron and Grey Iron Fittings for Water Supply Service.

5. AWWA C153 - Ductile- Iron Compact Fittings, 3-in through 24-in and 54-in through 64-in, for Water.

6. AWWA C550 – Protective Interior Coatings for Valves and Hydrants

7. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.

8. AWWA C651 - Disinfecting Water Mains.

9. AWWA M41 – Ductile Iron Pipe and Fittings Manual of Water Supply Practices

C. National Sanitation Foundation (NSF)

1. NSF 61 – Drinking Water System Components Health Effects.

1.05 QUALITY ASSURANCE

A. It is a requirement of these Contract Documents to have the ductile iron pipe under thus section designed and supplied by a single manufacturer rather than have selection and supply of these items by a number of different manufacturers. Similarly. It is a requirement of these Contract Documents to have the ductile iron fittings under this section designed and supplied by a single manufacturer rather than have selection and supply of these items by a number of different manufacturers. Connections between the fittings shall be compatible, as detailed in Section 1.06.

B. Ductile-iron fittings to be installed under this project shall be inspected and tested at the foundry as required by the standard specifications to which the material is manufactured. Furnish in duplicate to the OWNER sworn certificates of such tests and their results at least 5 days prior to the shipment of the goods.

C. Inspection of the fittings will also be made by the OWNER or representative of the OWNER after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the Specification requirements even though pipe may have been accepted as satisfactory at the place of manufacture. Fittings rejected after delivery (including defects from manufacturing or delivery/transport) shall be marked for identification and shall immediately be removed from the job at the CONTRACTOR's expense.

D. Pipe and fittings to be installed under this Contract may be inspected at the plant for compliance with this Section by an independent testing laboratory selected by the OWNER at the OWNER's expense.

E. A manufacturer's representative shall be made available to the OWNER and owner's representative during the manufacturing furnishing, transporting, and unloading of the pipe during installation and testing of the pipe to assist in insuring that the pipe is properly fabricated, transported, unloaded, stored in the field, joined and tested. Manufacturer's responsibilities relate only to the proper care and treatment of the pipe during these procedures and not the techniques or procedures used during installation and testing.

1. The designated factory representative shall be made available at any time the owner may request. The field or site representative shall be made available a minimum of 10 working days (time on site) during the project when requested by the owner.

2. The cost for the services of the factory representative, including expenses, shall be considered incidental to the project and will not be paid separately.

F. The manufacturer shall meet the following criteria and furnish the necessary project information, which demonstrates the required experience:

1. Experience shall include the successful fabrication of at least 50 fittings in compliance with AWWA C110 or C153 of the largest specified diameter or larger with similar lining/coatings within the past 5 years.

G. Fittings shall be marked in accordance with applicable AWWA standards. Legibly and permanently mark fittings, specials and appurtenances to be consistent with the laying schedule and marking drawings (if required) with the following information:

1. Manufacturer, date.

2. Size, type, class, or wall thickness.

3. AWWA Standard(s) produced to.

4. Special fittings, bends, and appurtenances requiring specific orientation will be appropriately marked with the words "TOP" in the correct position and in a consistent location.

1.06 DESCRIPTION OF SYSTEMS

A. Fittings may be made outside the United States, but shall be supplied by one of the named pipe manufacturers or approved equal. Fittings shall be as supplied by the American Cast Iron Pipe Co., U.S. Pipe and Foundry, Griffin Pipe Products, McWane Company or an approved equal who

is a member of the Ductile Iron Pipe Research Association (DIPRA). Ductile iron fittings shall be supplied by a single manufacturer. The fittings supplier shall certify in writing that their fittings are compatible with the supplied brand of pipe.

B. Pipe is to be installed in those locations shown on the Drawings, and only where specifically indicated.

C. CONTRACTOR is responsible for compatibility between joints of items they supply.

D. In the case of conflict between information on the Drawings and this section especially concerning pressures, coatings, linings minimum thickness. The information given in this section shall govern.

1.07 DELIVERY, STORAGE AND HANDLING

A. Care shall be taken in loading, transporting, and unloading to prevent injury to the fittings. See AWWA C600 and the referenced AWWA Standards for Shipping, handling and storage procedures. Fittings shall be examined as noted in Division 1. Any damage to linings or coatings discovered during the examination shall be repaired to the satisfaction of the OWNER at the cost of the CONTRACTOR, before proceeding with the work.

B. Under no circumstances shall the fittings be dropped or skidded against each other. Care shall be taken to preventing marring the pipe coating. Padded wooden pipe cradles, or chocks suitable for the protection of coatings shall be used between finished pipes and beneath them when pipes are placed upon rough surfaces.

C. Materials, if stored, shall be kept safe from damage. The interior of fittings and other appurtenances shall be kept free from dirt, excessive corrosion or foreign matter.

D. No metal tools or heavy objects shall be permitted to come in contact unnecessarily with the finished coating. Workers will be permitted to walk upon the coated pipe only when necessary, in which case they shall wear footwear with rubber or composition soles and heels that are sufficiently free of dirt and mud that coating remains undamaged.

PART 2 PRODUCTS

2.01 END TREATMENTS/JOINTS

A. Ductile iron pipe/fitting joints shall be push-on rubber gasket type or rubber-gasket mechanical joint. Joints for pipe and fittings shall be restrained. Gasket materials shall comply with Table 5-1 of AWWA M-41. Rubber-gasket joints shall conform to AWWA C111. Gasket shall be of styrene butadiene rubber (SBR).

B. Restraint for push on joint pipe shall be positive locking "Locked-type" joints manufactured by the pipe and fitting manufacturer that utilize restraint independent of the joint gasket. Restrained joints shall be suitable for the specified 200 psig test pressure. Joints shall be fabricated of heavy section ductile iron casting. Bolts and nuts shall be low carbon steel conforming to ASTM A193, Grade B7. Restraint for mechanical joint pipe shall use retainer glands for restraining joint. Restrained push on joints shall be by one of the following or approved equal:

- "TR Flex" by US Pipe and Foundary Company

- "Lok-Ring, "Flex Ring (positive locking style)" by the American Cast Iron Pipe Company
- "Snap Lok" by Griffin Pipe Products Company.
- "Superlok" by Clow Water Systems Company

1. The minimum number of restrained joints required for resisting forces at fittings and changes in direction of the pipe shall be determined from the length of restrained pipe on each side of the fittings and changes in direction necessary to develop adequate resisting friction with the soil. The required lengths of restrained joints shall be as shown on the Drawings.

2. Restrained pipe joints that achieve restraint by incorporating cut out sections in the wall of the pipe shall have a minimum wall thickness at the point of the cut out that corresponds with the minimum specified wall thickness for the rest of the pipe.

C. Threaded ductile iron flanges for ductile iron pipe shall be fabricated per AWWA C115 and sealed during installation with a special high pressure, full face gasket per AWWA C111. At the pipe manufacturer's option, the use of 250 lb pattern flanges, which are faced and drilled in accordance with ANSI B16.1 may be substituted in order to match valves or other equipment and/or to meet the required working pressure requirements. Flanges shall be rated for the same pressure as the adjacent pipe. Compatibility of the flanges with the 250 lb class and higher special class AWWA valves will the responsibility of the CONTRACTOR.

1. Flanges shall be pre drilled and then faced after being screwed onto the pipe, with flanges true to 90 degrees of the pipe axis and shall be flush with the end of the pipe.

2. Gaskets shall be full face rubber, 1/8" thick SBR material. Such as American Torseal Gasket, or approved equal. Special material ring gaskets such as those by Garlock or equal may be required for pressures exceeding 250 for ANSI rated and custom flanges.

3. Flanged joints shall be supplied with bolts and nuts on one end, bolt studs with a nut at each end, or studs with nuts on one end where the flange is tapped. The number and size of bolts shall comply with the same standard as the flange. Bolts and nuts shall, except as otherwise specified or noted in the Specifications or on the Drawings, comply with ASTM A193, grade B7.

4. Blind flanges shall mate with regular flanges.

2.02 FITTINGS

A. Pipe fittings shall be ductile iron with pressure rating of 350 psi for 24-in and smaller piping. Fittings shall meet the requirements of AWWA C110 or AWWA C153 as applicable. Fittings shall have the same pressure rating, as a minimum, of the connecting pipe.

B. Closures shall be made with mechanical joint ductile iron solid sleeves unless alternate approved coupling systems as described in paragraph 2.01D are used and shall be located in straight runs of pipe at minimum cover outside the limits of restrained joint sections. Location of closures shall be subject to approval of the OWNER.

C. Weld-on Outlets

1. As an alternative to ductile iron cast fittings, weld-on outlets may be used. Welded-on outlets shall be limited to branch outlets having a nominal diameter not greater than 30 percent of the

nominal diameter of the main pipe, or 14-inches diameter, whichever is smaller. Welded-on outlets may be provided as radial tee outlet, tangential outlet, or lateral outlet fabricated at a specific angle to the main pipe (in 1 degree increments between 45 and 90 degrees from the axis of the main pipe). Welded-on outlets shall be welded onto the pipe under the supervision of a qualified welder at the same facility where the pipe is manufactured. The ductile iron pipe manufacturer shall have a minimum of 5 years experience in the fabrication and testing of outlets of similar size and configuration. In no case shall field welding on of outlets be allowed.

2. The joints on welded-on outlets shall be compatible with the connecting pipe and meet where applicable, the requirements of ANSI/AWWA C111/A21.11 and/or ANSI/AWWA C115/A21.15.

3. Welding procedures for welded-on outlets shall be as determined by the pipe manufacturer.

   a. Parent pipe and branch outlet candidate pipe shall be centrifugally cast ductile iron pipe designed in accordance with ANSI/AWWA C150/A21.50 and manufactured in accordance with ANSI/AWWA C151/A21.51. Minimum class shall be: for sizes 4-inch through 54-inch, special thickness class 53.

   b. Welded-on outlets shall be rated for the working pressure indicated on the Drawings and the connecting pipe. Prior to the application of any coating or lining in the outlet area, weldments for branch outlets to be supplied for this project shall be subjected to an air pressure test of at least 15 psi. Air leakage is not acceptable. A hydrostatic test of 500 psi should also be allowed as an alternative. No leakage is allowed on the hydrostatic test. The hydrostatic test shall be done prior to cutting out the parent pipe. The rating, safety factor and testing must be certified and contained in the manufacturer's submittal package.

2.03 INTERIOR LINING

A. Ductile iron fittings shall have the same type of lining as specified herein.

B. Ductile iron fittings shall have a cement mortar lining in accordance with AWWA C104. The cement shall be per ASTM C150.

C. At the option of the supplier, fittings may be lined in accordance with AWWA C550. Lining shall be NSF 61 certified.

2.04 EXTERIOR COATING

A. Buried fittings shall be installed with a bituminous coating in accordance with AWWA C151 and C110 respectively.

B. Buried pipe and fittings shall be installed with polyethylene encasement. Polyethylene encasement shall have a minimum thickness of 8 mils and meet or exceed the minimum standards established by AWWA C105, current edition. Acceptable manufacturers include Fulton or approved equal.

   1. Polyethylene encasement shall meet minimum size requirements per TABLE 3 of section 2.15 of DIPRA's Installation Guide For Ductile Iron Pipe.

2. Test results from an independent testing agency certifying that the polyethylene encasement meets criteria established by AWWA C105, current edition, shall be submitted to the OWNER prior to approval of the polyethylene encasement for use. In general, samples shall be submitted and include test results in accordance with the AWWA standard associated with tensile strength, elongation, dielectric strength, impact resistance, and propagation tear resistance.

3. A 2-inch wide plastic adhesive tape, such as Calpico Vinyl, Polyken 900, or approved equal, shall be used for sealing seams, cuts, or tears in polyethylene encasement. Duct tape shall not be allowed.

PART 3 EXECUTION

3.01 GENERAL

A. Care shall be taken in loading, transporting and unloading to prevent injury to the fittings, lining or coatings. Fittings shall not be dropped or skidded against each other. Fittings shall be examined before laying and no piece shall be installed which is found to be defective. Any damage to the fittings, lining or coatings shall be repaired per manufacturer's recommendations. Handling and laying of fittings shall be in accordance with manufacturer's instruction and as specified herein.

   If any defective fittings are discovered after it has been laid, it shall be removed and replaced with a sound fitting in a satisfactory manner. Fittings shall be thoroughly cleaned before laying, shall be kept clean until they are used in the work and when installed or laid, shall conform to the lines and grades required.

B. Materials, if stored, shall be kept safe from damage. The interior of fittings and other appurtenances shall be kept free from dirt, excessive corrosion or foreign matter.

C. Gaskets for mechanical and push-on joints to be stored shall be placed in a cool location out of direct sunlight. Gaskets shall not come in contact with petroleum products. Gaskets shall be used on a first-in, first-out basis.

3.02 INSTALLING DUCTILE IRON FITTINGS

A. Ductile iron fittings shall be installed in accordance with requirements of AWWA C600, except as otherwise specified herein. A firm, even bearing throughout the length of the pipe shall be provided by digging bell holes at each joint and by tamping backfill materials at the side of the pipe to the springline per details shown on the Drawings. Blocking will not be permitted. If any defective fitting is discovered after it has been laid, it shall be removed and replaced with a sound fitting in a satisfactory manner by the CONTRACTOR, at his/her own expense.

   Fittings shall be kept clean until they are used in the work and shall be sound and thoroughly cleaned before laying. When laid, the fittings shall perform to the lines and grades required. Sufficient backfill shall be placed to prevent flotation.

   Ductile iron fittings laid underground shall have a minimum of 4 of feet of cover unless otherwise shown on the Drawings or as specified herein.

Fittings, in addition to those shown on the Drawings shall be provided, where required, in crossing utilities which may be encountered upon opening the trench. Solid sleeve closures shall be installed at locations approved by the OWNER.

3.03 PIPE JACKING

A. Pipe jacking is specified in Section 02151.

3.04 CLEANING

A. At the conclusion of the work, thoroughly clean fittings by flushing with water or other means to remove dirt, stones, pieces of wood, or other material which may have entered during the construction period. Debris shall be removed from the pipeline. The lowest segment outlet shall be flushed last to assure debris removal.

B. After the fitting has been cleaned and if the groundwater level is above the pipe or water in the pipe trench is above the pipe following a heavy rain, the OWNER will examine the pipe for leaks. If defective fittings or joints are discovered at this time, they shall be repaired or replaced by the CONTRACTOR.

3.05 DISINFECTION

A. Ductile iron fittings used for recycled water service shall be disinfected after cleaning. Provide necessary equipment and labor for the disinfection.

B. Disinfection shall be in accordance with AWWA C651 standard.

C. Discharge of chlorinated water shall comply with Federal, State and local standards. Provide sodium bisulfite for dechlorination prior to discharge.

END OF SECTION

SECTION 02617

BURIED STEEL PIPE AND FITTINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Installation of 18 and 24-inch diameter buried steel piping. Supply, deliver, and install other miscellaneous piping, fittings, and appurtenances (regardless of size). This shall include, but not be limited to: welding inside and outside joints, installation of harnessing and special couplings, mortar for inside, and tape wrap or coating system outside of pipe (except at valves that may have flanged ends).

B. Unless otherwise noted, "pipe" shall mean pipe work of any type including pipe, fittings, joints, or appurtenances.

C. Cathodic protection is required for steel pipe. Details of cathodic protection and spacing requirements are shown on the Drawings and as specified in Division 13.

1.02 RELATED WORK

A. Earthwork is included in Division 2.

B. Corrosion protection procedures are included in Division 13.

C. Valves, couplings, additional restraint, and appurtenances are included elsewhere in Division 2.

D. Buried Valves, hydrants and related appurtenances are included in Section 02640.

1.03 SUBMITTALS

A. Shop drawings, including piping layouts, design calculations, test reports, warranty information, and schedules.

B. Prior to each shipment of pipe, submit certified copies of mill tests confirming the type of materials used in steel plates, mill pipe flanges, and shop testing of pipe to show compliance with the requirements of the applicable standards, along with an affidavit of compliance that the pipe linings and coatings comply with the referenced standards.

C. Submit results of shop testing including hydrostatic tests.

D. Submit strutting details as discussed in paragraph 1.07.

E. Submit shop drawings with a tabulated layout schedule showing the location of each piece, by mark number, for the work furnished under this Contract; method of manufacture and installation of pipe; joint details; fittings; and any specials. Shop drawings shall include, but not be limited to:

1. Complete and dimensional working drawings of pipe layouts, including pipe stationing, invert elevation at changes in grade or horizontal alignment, elements of curves and bends, both in horizontal alignment and vertical position.

2. The grade of material; size, wall thickness of the pipe and fittings, type and location of fittings, specials, and valves; and the type and limits of the lining, lining reinforcing, and coating systems of the pipe and fittings. Methods and procedures recommended by the coating manufacturer shall be documented, particularly, as it pertains to minimizing voids at weld seams, application procedures, and locations of weld seam tape if required. Seam tape is not required if the manufacturer can demonstrate adequate control of weld bead height. Maximum weld seam height will be 1/16-in. Submit affidavit of compliance that tape coating systems comply with reference standards (AWWA C214 or C209, as applicable).

3. Joint details; methods, and locations of supports; and complete information concerning type, size, and location of welds. Shop and field welds shall be clearly differentiated, and welds will be clearly detailed with preparation procedures for pipe and parent metal comprising each weld. Critical welding procedures shall be identified along with methods for controlling welding stresses and distortions. Locations and proposed joint details or butt straps used to control temperature stresses in the shop and field shall also be clearly identified.

4. Other pertinent technical information for items to be furnished; product data to show compliance of couplings, supports, fittings, coatings, and related items.

F. Submit design calculations noted under paragraph 2.03 signed by a Professional Engineer registered in the State of California and welders' qualifications as noted above and under paragraph 1.05.

G. Submit handling procedures for phases from finished fabrication through delivery, including storage, transportation, loading, and unloading. This will include storage at project site and required protection following installation prior to startup.

H. Submit information on warranties.

1.04 REFERENCE STANDARDS

A. American Water Works Association (AWWA)

1. AWWA C200 - Steel Water Pipe-6 In. (150 mm) and Larger

2. AWWA C203 – Coal-Tar Protective Coatings and Linings for Steel Water Pipelines – Enamel and Tape – Hot Applied.
3. AWWA C205 - Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 In. (100 mm) and Larger - Shop Applied

4. AWWA C206 - Field Welding of Steel Water Pipe

5. AWWA C207 - Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In.

6. AWWA C208 - Dimensions for Fabricated Steel Water Pipe Fittings

7. AWWA C209 - Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines

8. AWWA C210 - Liquid-Epoxy Coating System for the Interior and Exterior of Steel Water Pipelines

9. AWWA C214 - Tape Coating Systems for the Exterior of Steel Water Pipelines

10. AWWA C216 - Heat-Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines

11. AWWA C219 – Bolted, Sleeve-Type Couplings for Plain-End Pipe.

12. AWWA C222 – Polyurethane Coatings for Interior and Exterior of Steel Water Pipe and Fittings

13. AWWA C606 - Grooved and Shouldered Joints

14. AWWA C651 - Disinfecting of Water Mains

15. AWWA M11 - Steel Water Pipe - A Guide for Design and Installation (Manual of Water Supply Practices)

B. ASTM International

1. ASTM A36 - Standard Specification for Carbon Structural Steel

2. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

3. ASTM A139 - Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over)

4. ASTM A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service

5. ASTM A194 – Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both

6. ASTM A234 - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service

7. ASTM A283 - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates

8. ASTM A370 – Standard Test methods and Definition for Mechanical Testing of Steel Products

9. ASTM A572 - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel

10. ASTM A1011 - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, and Ultra High Strength

11. ASTM A1018 - Standard Specification for Steel, Sheet and Strip, Heavy Thickness Coils, Hot-Rolled, Carbon, Commercial Drawing, Structural, High Strength Low Alloy, High Strength Low Alloy with Improved Formability, and Ultra-High Strength Steel

12. ASTM C150 - Standard Specification for Portland Cement

13. ASTM E709 - Standard Guide for Magnetic Particle Examination

C. American National Standards Institute (ANSI)

1. ANSI B2.1 - Pipe Threads, Except Dry Seal

2. ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings

3. ANSI B16.5 - Steel Pipe Flanges and Flanged Fittings

4. ANSI B16.9 - Factory-Made Wrought Steel Butt Welding Fittings

5. ANSI B16.11 - Forged Steel Fittings, Socket Welding and Threaded

D. Miscellaneous Specifications and Standards listed below shall also apply to this Section.

1. American Welding Society (AWS)

2. American Society of Mechanical Engineers (ASME)

1.05 QUALITY ASSURANCE

A. The manufacturer shall meet the following minimum criteria:

1. Certification by the Steel Plate Fabricators Association (SPFA) or certification under International Standards Organization (ISO) quality control standards at the discretion of the OWNER.

2. Experience that includes successful fabrication (followed by installation, acceptance and service) to AWWA C200 standards of at least 50,000-lineal-feet of 24-in diameter or larger pipe, with wall thickness of 3/16-in or greater, within the past 5 years. Such experience shall be demonstrated at the specific plant facility proposed for manufacture associated with this project.

3. Experience that includes successful fabrication (followed by installation, acceptance, and service) of at least 50 fittings in compliance with AWWA C208 standards with similar linings/coatings and wall thickness as the adjacent pipe, within the past 5 years. Such experience shall be demonstrated at the specific plant facility proposed for manufacture associated with this project.

B. It is a requirement of these Contract Documents to have fabricated pipe and fitting items under this Section designed and supplied by a single manufacturer rather than have selection and supply of these items by a number of different manufacturers.

C. The Contractor is responsible for the performance of inspection and testing requirements as specified in the referenced standards. Furnish in duplicate to the OWNER, signed certificates of

such test and their results at least 5 days prior to shipment of the goods. In addition, pipe and fittings to be installed under this Contract may be inspected at the plant by the OWNER for compliance with this Section including using an independent testing laboratory selected and paid for by the OWNER. The Contractor shall notify the OWNER in writing at least 14 days in advance of any phase of the pipe manufacture.

D. Material tests shall be performed at no additional cost to the OWNER and OWNER may witness testing conducted on pipe or materials used in manufacture and fabrication. OWNER may request additional samples of material such as concrete, lining, coating, etc. for independent testing. Such samples will be furnished at no additional cost to OWNER.

E. Design calculations for pipe and fittings including wall thickness and stress analysis shall be submitted, along with items noted under paragraph 1.03. Calculations shall be signed and sealed by a Professional Engineer registered in the State of California.

F. Automatic and manual welding procedures used in fabrication of pipe, fittings, and appurtenances shall be prequalified under Section IX of the ANSI/ASME Boiler and Pressure Vessel Code or AWS B2.1. Welding procedures shall be required for, but not necessarily limited to, longitudinal and girth or spiral welds for pipe cylinders, spigot and bell ring attachments, reinforcing plates and ring flange welds, and plates for harness and lug connectors. Factory welding shall be done by certified welders. Welders shall be qualified under the provisions of AWS D1.1 and AWWA C206 by an independent local, approved testing agency in advance of any pipe production. Machines and electrodes similar to those used in the work shall be used in qualification tests and Contractor shall furnish material and bear the expense of qualifying welders. Submit welder qualifications.

G. In addition to the tests required in AWWA C200, weld tests shall be conducted on 5,000-ft maximum intervals of production welds and at any times there are changes in the grade of steel, welding procedure, or welding equipment. A minimum of five weld tests shall be conducted regardless of length.

H. Inspection of the pipe and fittings will be made by OWNER after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the requirements specified herein, even though sample pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery (including for defects from manufacturing or delivery/transportation) shall be marked for identification and shall be removed from the job at once at the expense of the Contractor.

I. Shop Testing

1. Straight pipe sections shall be hydrostatically tested in the shop to the test pressures determined by Section 5.2 of AWWA C200 after fabrication and prior to application of the specified protective coatings or wrappings. Other nondestructive shop test methods approved by the OWNER may be used in lieu of hydrostatic testing of fittings and specials. If the fittings are made from hydrostatically tested pipe then only NSF approved dye testing or wet magnetic particle testing, in compliance with ASTM E709, of the welds is required.

1.06 DESCRIPTION OF SYSTEMS

A. Piping shall be installed in those locations as shown on the Drawings, and only where specifically indicated.

B. Dimensions and elevations for buried shall be field verified by the Contractor.

C. The items and materials specified herein are intended to be standard steel pipe for use in transporting recycled water.

D. Note information in drawings, if any, and in this Section especially concerning pressures, coating and linings, minimum thickness, etc. In case of a conflict, the more stringent information in OWNER's opinion shall govern.

E. Note that Contractor is responsible for compatibility between their pipe, flanges, valves, etc.

1.07 MARKINGS, HANDLING, AND STORAGE

A. Legibly mark pipes, fittings, specials, and appurtenances to be consistent with laying schedule and marking drawings. Each pipe shall be identified with sequential numbering and each marked pipe will appear on marking drawings in the identified locations for installation. Special fittings, bends, and appurtenances requiring a specific orientation will be appropriately marked with the words "TOP" in the correct position and in a consistent location.

B. Care shall be taken in loading, transporting, and unloading to prevent injury to the pipe or coatings. See also AWWA C214 and/or C222 and the referenced AWWA manual for shipping, handling, and storage procedures. Pipe or fittings shall not be dropped. Any damage to linings or coatings discovered during examination shall be repaired to the satisfaction of the OWNER at the Contractor's cost before the pipe is installed. Pipe shall be transported from the coating plant to the jobsite on padded bunks with nylon tie-down straps or padded banding to adequately protect the pipe and coating. Pipe shall not be stacked higher than the limits recommended by its manufacturer.

C. Pipe and fittings shall be thoroughly cleaned, and shall be kept clean until they are used in the work.

D. Lined and coated pipe shall be suitably protected from exposure and heating of the sun following procedures recommended by the coating system manufacturer. Exposure will not be allowed (except for short periods such as installation, assembly, and coating repairs). If the coating system includes UV inhibitors and the manufacturer will guarantee the coating against UV related damage, longer exposure may be permitted at the discretion of the OWNER.

E. In handling the pipe, a double 2-ft wide cushioned sling shall be used or other devices and methods acceptable to the OWNER. No uncushioned ropes, chairs, wedges, cables, or levers shall be used in handling the finished pipe, fittings, or couplings. Care should be taken not to mar the pipe's outer coating. Padded wooden pipe cradles or chocks suitable for protection of tape coatings shall be used between fabricated pipes and beneath them on rough surfaces when pipes are stacked. Pipe shall not be stored on bare ground unless soft sand berms are used to support the pipe.

F. No metal tools or heavy objects shall be permitted to come into contact unnecessarily with the finished coating. Workers will be permitted to walk upon the coating only when necessary, in which case they shall wear shoes with rubber or composition soles and heels.

G. It shall be the responsibility of the Contractor to prevent damage to the linings or coating that might be caused by handling and/or storage of the completed pipe at low temperature (due to embrittlement) or high temperatures or direct sunlight.

H. Adequate strutting (stulling) shall be provided on specials, fittings, and straight pipe, so as to limit handling and storage damage to the pipe coating and lining. The strutting shall be installed by the manufacturer and shall remain in place while each pipe is loaded, transported, unloaded, and backfilled at the job site. Strutting shall be adequate for all handling, hauling, and storage. Struts shall be left in the pipe until backfill is complete. Additional strutting required to prevent damage and excess deflection of the pipe during installation due to loads imposed by backfilling and compaction equipment shall be the responsibility of the installation contractor. Pipe damaged during any phase of handling, hauling, storage, or installation due to improper strutting will be repaired or replaced at no expense to OWNER. Submit informational review details on strutting assembly to OWNER prior to pipe manufacture.

1.08 WARRANTIES

A. Provide manufacturer warranties for items included in this specification.

PART 2 PRODUCTS

2.01 MATERIALS - GENERAL

A. Description. Pipe shall comply with the applicable standard depending on the proposed piping system as designated by the pipeline sizes shown on the drawings, or if none is shown, as noted below.

Pipe Size	Description
18” & 24”	Cement mortar lined and tape coated Steel

B. Closures and corrections or makeup pieces shall be provided as required so that closures may be made due to different construction headings in the pipe-laying operation so as to adjust pipe installation to conform to pipe stationing. Locations of such pieces shall be identified on submittals and acceptable to OWNER.

2.02 METHOD OF MANUFACTURE

A. Fabricated Steel Pipe

1. Pipe shall be fabricated from steel sheets or plate in accordance with AWWA C200, Section 4. Fabrication from steel plate shall conform to ASTM A36 and/or A283, Grade C or ASTM A572, Grade 42. If sheet coil is used, it shall also conform to the requirements of ASTM A139, Grade B or C.

2. Steel used in the fabrication and manufacture of pipe, fittings, and related appurtenances shall have a maximum carbon content of 0.25 percent and shall have a minimum elongation of 22 percent in a 2-in gauge length.

3. Steel used in fabrication and manufacture of pipe, fittings, and related appurtenances shall be produced by continuous cast method, fully killed and of fine austenitic grain size. At the discretion of the OWNER, some exceptions may be allowed for appurtenances such as

reinforcing collars, reducers, butt straps, etc. which are not fabricated from manufactured pipe sections.

4. Each heat of steel used in fabricating pipe, where coil thickness exceeds 0.188 inch, shall be tested for notch toughness using the Charpy V-notch test. The minimum impact value shall be 25-lbf-ft at a temperature of 30 degrees F. Charpy V-notch specimens shall be prepared in accordance with ASTM A370. Filler material shall meet the same toughness properties as the base metal.

5. Except for seamless mill-type pipe, piping shall be made from steel plates rolled into cylinders or sections thereof with not more than two longitudinal butt welded seams or shall be spirally formed and butt welded. Girth seams shall be butt welded and shall be no closer than 6-ft except in specials and fittings. Welding shall utilize an approved electro-fusion weld process.

2.03 WALL THICKNESS DESIGN

A. Wall Thickness

1. Fabricated steel pipe shall be designed in accordance with the latest edition of AWWA M11. References below are to the 2004 (Fourth edition) of AWWA M11.

2. Wall thickness design shall be based on:

a. Wall thickness for minimum handling shall be a minimum of D/T of 200 defined as outside diameter divided by wall thickness.

b. AWWA M11, including Chapters 4, 5, and 6, especially Good Practice in Chapter 4 concerning pipe material stresses.

c. Maximum internal static (working) design pressures, internal design pressures shall be equivalent to 150 psi.

d. Maximum external loads for buried pipe design shall include:

(1) HS-20 and Cooper E-80 loading at minimum earth cover (identified in Chapter 6, AWWA M11).

(2) Other items in Chapter 6 of AWWA M11, including equation 6-4 for prism loading. Do not decrease dead load (Wc) by any factors.

(3) For piping, utilize E' factors based on having moderate compaction of bedding (per Table 6-1 – as modified by Errata July 2004 - in AWWA M11), unless lower E' values are indicated in the geotechnical investigation. In no case shall E' exceed 1,000 psi.

(4) Calculation for deflection shall be based on the modified Iowa formula (EQ. 6-5, AWWA M11). Deflection of pipe, in place, shall not exceed 2 percent. Deflection lag factor shall be 1.0 and bedding constant shall be 0.10.

d. Internal pressure design

(1) Operating pressure is 150 psi. Test pressure is 225 psi.

(2) Water temperature: 70 degrees F maximum, 34 degrees F minimum.

(3) Maximum Working Stress:

(a) The stress due to design pressure shall be no greater than 50 percent of the minimum yield strength. However, regardless of the yield strength of the steel, the maximum combined stress based on design pressure shall never exceed 21,000 psi or 50 percent of yield strength for the grade and class of steel (whichever is lower).

(b) The stress due to test pressure shall not exceed 75 percent of the minimum yield strength. However, regardless of the yield strength of the steel the maximum combined stress based on test pressure shall not exceed 31,500 psi or 75 percent of yield strength for the grade and class of steel (whichever is lower).

3. In no case shall wall thickness be less than 3/16” based on yield strength of steel no greater than 42 ksi.

4. Note: Design calculations for wall thickness shall be submitted under PART 1 of this Section.

5. Bends, fittings, branch connections, wall pieces with integral thrust flange, and special sections where fabricated shall be reinforced or shall have their shell thickness increased so that the combined stresses due to operations and/or testing are in accordance with the requirements noted above. Whether or not shown on the Drawings, the manufacturer shall determine and provide reinforcements or additional shell thickness as required to keep the combined stresses within the specified maximum. Reinforced design shall conform to Chapter 13 of AWWA M11 including the addition of crotch plates, wrapper plates, and collar pads as required. Shell thickness for reducing fittings shall be equal to that required by the thickest connecting pipe. See paragraph 2.04.

B. Diameter. Nominal pipe diameter shall be as shown on the Drawings. Unless otherwise specified, the diameter shall be as follows:

1. Fabricated Steel Pipe: Larger than 18-in nominal size, the diameter noted shall be equal to the actual clear diameter from mortar lining surface to mortar lining surface.

2.04 FITTINGS/JOINTS

A. Fittings and specials shall be fabricated in accordance with AWWA C200, Section 4, including nondestructive testing in accordance with AWWA C200, Section 5 by NSF approved dye penetrant or wet magnetic particle testing of welds not previously tested in the straight pipe.

1. Fittings shall conform to the dimensions of AWWA C208 or may be fabricated into standard pipe lengths.

2. Angles up to 5 degrees may be accomplished using joint deflections or mitered end joints as proposed by the manufacturer. Elbows 5- to 22-1/2-degrees shall be two piece, greater than 22-1/2- to 45-degrees shall be three piece, greater than 45- to 67-1/2-degrees shall be four piece, and greater than 67-1/2- to 90-degrees shall be five piece.

3. Tees, wyes, laterals, and outlets shall be reinforced in accordance with ASME Pressure Vessel Code, Section VIII; or AWWA M11, Sections 13.

4. Fittings and specials not detailed on the drawings shall conform to the details furnished by the Contractor as approved by the OWNER.

B. Pipe ends/joints shall be:

Pipe Size/Type	Ends/Joints (if not noted otherwise)
Fabricated Steel	Single and double lap weld, butt welded for thicknesses greater than or equal to 0.625-in (5/8-in) Flanged (where required for valves) O-ring (where allowed)

C. Welded/Fabricated

1. Forged steel fitting shall comply with ANSI B16.11.

2. Butt-welded fittings shall comply with ANSI B16.9.

3. Wrought carbon steel fittings of seamless or welded construction shall comply with ASTM A234.

4. Fabricated steel fittings shall comply with AWWA C-200, shall be of the same material as pipe, and shall comply with AWWA C208.

5. Restrained joints where required at changes in direction or shown on the drawings shall be single or double welded lap joints. Design of the joint and welds shall include considerations of stresses induced in the steel wall, the joints, and any field welds, caused by thrust at bulkheads, bends, reducers, and line valves resulting from the working and/or transient pressure.

6. For field welded joints, design stresses shall not exceed 50 percent of specified minimum yield strength of the grade of steel utilized for the part being examined when longitudinal thrust is assumed to be uniformly distributed around the circumference of the joint.

D. Flanged Joints

1. Flanges will be provided at valve connections and as otherwise indicated on the Drawings.

2. Flanges shall be machined to flat face using 1/8-in thick full face rubber gaskets suitable for potable water service. Flanges and gaskets shall be capable of meeting or exceeding the operating and test pressures cited in the pipe schedule on the drawings Blind flanges or dish heads furnished for testing purposes at valves shall meet the minimum test pressures.

3. Flanges shall meet the following requirements:

Design Operating Pressure	Governing Standard
150 psi	AWWA C207, Class D, Table 1, 3

4. Compatibility of flanges, including drilling and sizing of flanges and bolts, shall be coordinated by Contractor to insure compatibility with OWNER and Contractor furnished valves.

5. Flange faces shall be normal to the pipe axis with a maximum tolerance of 0.005-in/ft of flange diameter. Angular deflection (or layback) of the flange face shall not exceed 0.75 degree from a plane surface and shall be uniform within 0.010-in. Flanges, after welding to the pipe, shall be measured and shall be refaced, if necessary, to bring them within the specified tolerances. Flanges shall only be welded in the shop.

6. Bolts and hardware shall be ASTM A193, Grade B7 and ASTM A194, Grade 2H (nuts), installed length to project approximately 1/2-in beyond surface of nuts, except Type 316 stainless steel on buried and submerged flanges.

7. Proper lubricants, washers and torque procedures shall be used on assembly of flanges in accordance with Chapter 12 of AWWA M11 and as required by the flange manufacturer.

8. Flange insulating kits shall be utilized between dissimilar metals and where otherwise noted.

E. Joints

1. O-Ring Joints (where specified).

   a. The spigot end of the pipe shall have a rolled in groove designed to retain the O-ring rubber gasket. Joints consisting of a Carnegie shape joint ring for spigot end or flared bell end and a grooved spigot end shall also be acceptable. Bell and spigot ends shall be sized by forcing over a sizing die or by expanding to stretch the steel beyond its elastic limit so that the difference in diameter between outside of spigot and inside of bell at normal engagement does not exceed 0.400-in measured on the circumference with a diameter tape. The O-ring gasket shall have sufficient volume to approximately fill the area of the groove and shall conform to AWWA C200. Manufacturer shall submit test reports on gaskets to be used in construction consistent with section 4.13.6.3 of AWWA C200. The bell and spigot with flared bell and grooved spigot end shall be submitted for review complete with dimension data and tolerances. Performance data shall be required demonstrating that the joint has performed satisfactorily under the anticipated operating conditions.

   b. The joint shall be suitable for a safe working pressure equal to the class of pipe furnished and shall operate satisfactorily with a deflection (the tangent of which is not to exceed 0.75-in divided by D where D is the outside diameter of the pipe in inches) or with a pullout of 0.75-in. In no case will O-ring gasket joints be allowed for design working pressures in excess of 250 psi (maximum static working pressure of 250 psi, maximum test pressure of 350 psi). Note welding requirements for certain pipe.

c. O-ring joints shall be electrically bonded using bonding wire filter rings and brazing cartridges furnished by the pipe fabricator. The Contractor shall be responsible for checking the continuity of this system before final acceptance.

2. Lap Joints for Double Lap Welding.

a. All lap joints shall be single or double welded (inside and outside) unless pipe diameter is 24-in or smaller, in which case only single lap exterior weld or double exterior weld butt strap is acceptable.

b. All bell ends shall be formed by expanding with segmental dies using a hydraulic type expander, or by die pressing in such a manner as to stretch the steel plate beyond its elastic limit to form a truly round bell. No process will be permitted in which the bell is formed by rolling. Preformed welded bell and spigot joints (Carnegie shapes) will not be allowed. The post formed section shall have a minimum radius of curvature of the bell end at any point of not less than 15 times the thickness of the steel shell. Longitudinal or spiral welds extending into the bell and spigot sections of lap joints shall be ground flush with the surrounding metal a minimum of 18-in from the ends. Burrs and sharp edges on the inside of bells and outside of spigots will also be ground flush or lightly chamfered.

c. Field joints shall be assembled so that seams in adjacent pipe sections are offset from each other by at least five times the thickness of the thinner of the pipes being joined. Minimum sectional overlap of the joint shall be at least 1-1/2-in or four times the thickness of the thinner of the pipe wall thicknesses being joined, whichever is greater. The inside circumference of the bell section shall not exceed the outside circumference of the spigot section by more than 0.400-in in accordance with AWWA C200. No part of any field weld shall be closer than 1-in to the nearest point of tangency to a bell radius.

3. Butt Joints for Welding

a. Butt joints shall be used where pipe wall thicknesses exceed 5/8-in. Butt joints shall be single V-groove butt joints. The butt joints shall be complete joint "full" penetration welds.

b. Field joints shall be assembled so that seams in adjacent pipe sections are offset from each other by at least five times the thickness of the thinner of the pipes being joined. Joints shall be accurately aligned and retained in position during welding operations so that the finished joint has abutting lining sections that are not misaligned by more than 20 percent of the wall thickness of the pipe or 1/8-in, whichever is smaller.

c. Welder qualifications shall follow requirements cited elsewhere in this Section.

d. Backing rings shall be used to assist in lining up pipe joints and for completion of welds. Rings shall be a minimum of 4-in in width and 1/4-in in thickness and shall avoid interference with internal joint finishing.

e. For pipe greater than 1/2-in in thickness, field and fabrication welders and welding procedures shall be qualified to provide notch tough welds. A Charpy test will be performed on jointed specimens meeting a minimum CVN value of 25 lbf-ft at 30

degrees F. Transverse specimen heat-lot testing for the steel shall be used, and filler materials shall meet the same CVN requirements.

4. Butt Straps

a. Butt straps shall comply with requirements of AWWA C200 and C206 and shall have a minimum shell thickness equivalent to the greatest thickness of the pipe sections being joined. Minimum butt strap width will be at least 12-in for 24-in and smaller pipe and 18-in for 36 inch and larger pipe (greater than 24-in nominal). Minimum overlap on each section of pipe being joined shall be 2-in. For smaller pipes butt strap width shall be sufficiently wide to result in a minimum overlap of 1-in on each pipe or four times the thickness of the greatest shell thickness of the pipes being joined, whichever is greater. Butt straps will be welded on the outside only for 24-in and smaller pipe. For larger pipe double lap weld joint pipe is required unless special welded closures are needed.

5. Thermal Control

a. For control of thermal stresses in the field, the Contractor shall submit a detailed method and procedure for proposed control of thermal stresses. Unless otherwise allowed, control of thermal stresses shall consist of proper temperature control and shading unbackfilled weld joints and use of controlled closure welds. Properly supported awnings or other suitable materials shall be used to protect unbackfilled joint areas for a minimum period of 2 hours prior to beginning the welding operations and until the weld has been completed. Good air circulation shall be maintained around the pipe throughout the shading period. Shading may be eliminated when ambient air temperatures drop below 45 degrees F.

b. Controlled closure welds shall be applied at the locations shown on the Drawings, but a maximum of 500-ft apart.

(1) Controlled closure welds are defined as a double welded lap (or single lap joint if specified for in-line joints) joint that is welded after trench backfill has been completed for a 200-ft length of pipe on both sides of the closure.

(2) This closure shall be conducted during the coolest part of the day such as early morning and prior to direct sunlight acting on the site of the closure. Welding of closures is subject to the temperature limitations and preheating requirements associated with cold weather as specified in AWWA C206 and in paragraph 3.02 of this Section.

d. Restrained harnessed sleeve couplings are also required at special locations, such as adjacent to isolation valves, blowoff tees, connecting tees, at cathodic test station connections, and elsewhere as noted on the Drawings.

6. For Fitting with Flanges: Ends to be fitted with slip-on flanges shall have the longitudinal or spiral welds ground flush in accordance with the governing standard.

F. Couplings/Adaptors

1. Special mechanical couplings where indicated on the drawings shall be Victaulic Depend-O-Lok Styles F x F (self-restrained) in compliance with AWWA C219 as applicable.

Middle ring shall be of a thickness equal to or greater than the thickness of pipe wall. Couplings shall have plain gaskets, Grade 27 (Buna S) and shall be shop coated with Dresser Red "D" or primer compatible with the coating system. Special couplings shall be furnished complete with bonding wire and brazing cartridges. For F x F couplings, manufacturer shall submit performance reports of unrestrained axial proof of design tests to the OWNER prior to approval. Pipe joint preparation and end ring installation shall only be performed by the pipe manufacturer under controlled shop conditions. Such testing conditions and acceptability is entirely at the discretion of the OWNER.

2. Other ends shall be of the proper diameter and construction for any couplings, mechanical joint, or other ends to fit the respective connecting piece.

3. Contractor shall supply any insulated adapter where the pipeline is connected to existing pipe or dissimilar metals.

4. Buried sleeve-type couplings shall have a protective wrapping of "Denso" material by DENSO Inc. of Texas or equal. Where "Denso" material is used, the joint shall be packed up with "Densyl mastic" to give an even contour for wrapping with "Densopol" tape. A 1.5 mm thick coating of "Denso" paste shall be applied following by 100 mm or more wide "Densopol" tape wound spirally round the joint with at least 50 percent overlap.

2.06 RESTRAINED DISMANTLING JOINTS

A. Restrained dismantling joints shall be rated at the working pressures of the joining piping or 150 psi, whichever is greater. Tie rods shall be high tensile strength steel per ASTM A193 Grade B7. All joints shall be factory cleaned and given a fusion bonded epoxy coating in accordance with AWWA C213 and be NSF61 approved. The end ring and body shall be made of steel meeting ASTM A36. Bolts and nuts shall be 304 stainless steel. Gaskets shall be NBR. Restrained dismantling joints shall be Romac DJ400, JCM, Dresser or equal.

2.07 SUPPLEMENTAL RESTRAINED JOINTS ON STEEL PIPE

A. Lugs and connections to the pipe shall be welded on the pipe when it is fabricated, except as acceptable to the OWNER. Restrained joints, where required on the drawings, shall be harnessed sleeve coupling (AWWA C219), single or double welded (inside and outside) lap joints as required at locations shown on the Drawings, or butt-welded joints, as required.

B. Where harnesses are required for sleeve-type couplings, they shall be in accordance with the requirements of AWWA M-11 as modified on the drawings. Pipe ends for mechanical couplings shall conform to AWWA C200 Section 4.13 and in accordance with manufacturers' recommendations. The shop applied outside coating shall be held back as required for field assembly of the mechanical coupling or to harness lugs and rings. Harness lugs or rings and pipe ends shall be painted with an approved epoxy or polyurethane coating system compatible with field joint coating materials. The inside lining shall be continuous to the end of the pipe.

2.08 SHOP LININGS AND COATINGS, SURFACE PREPARATION

A. Linings and coatings are to be factory applied, smooth, and dense and shall be free of excessive surface crazing and roughness.

B. Interior surfaces of steel pipe, fittings, and specials shall be cleaned and lined in the shop with cement mortar lining applied centrifugally in conformity with AWWA C205. Wire mesh

reinforcement shall be used in gunited mortar lining of fittings and specials. Lining thickness shall be uniform and in compliance with AWWA C205. Minimum under tolerance will be -1/16 inch and maximum over tolerance shall be +1/8 inch.

1. The proportion by weight of cement to sand shall be approximately 1:1 for carbonation corrosion resistance.

2. Cement shall be Type II.

3. The water-soluble chloride ion content of the mortar shall not exceed 150 milligrams in 1000 grams of mortar.

4. Lining shall be NSF 61 approved for recycled water.

C. Non-shrink grout employed in the interior joints shall be Masterflow 713 grout by Master Builders or equal.

D. Pipe shall be coated and wrapped outside with "Pre-Fabricated Multilayer Cold Applied Polyethylene Tape Coating" in accordance with AWWA C214. Tape coating systems shall be as manufactured by Covalence-Polyken, Tek-Rap Inc., or equal. The total thickness of coating shall be 80 mils consisting of: primer, 20 mil inner layer for corrosion protection and two 30 mil outer layers for mechanical protection.

1. Shop applied outside coating shall be continuous to the end of pipe on the bell end and shall be cut back on spigot end so that coating extends at least 0.5-in inside of the bell end at normal engagement. Shop applied inside lining shall be continuous to the end of pipe on the spigot end and shall be cut back on the bell end to the point of maximum engagement or further as shown on drawings. Inside of bell and outside of spigot shall be painted with one shop coat of primer (Polyken No. 927 or equal).

2. Prior to shipment, the pipe shall be given an electrical holiday test of a minimum of 6000 Volts with a 60 cycle current audio detector giving a maximum testing voltage 120 times per second. Prior to placement, the pipe shall be visually inspected for damage to the coating. Any areas that appear damaged shall be given an electrical holiday test of a minimum of 6000 Volts with a 60 cycle current audio test giving a maximum testing voltage 120 times per second. If the tests indicate no holidays and the outer wrap is wrinkled but not torn, no repairs are required. If the tests indicate no holidays and the outer wrap(s) is torn, the damaged layer or layers of the outer wrap shall be removed by carefully cutting with a sharp razor-type utility knife. The area to be patched shall be washed with xylol taking care to wash a minimum of 4-in of undamaged tape where the hand applied tape wrap will overlap. Cold applied tape (outer wrap) meeting the requirements of AWWA C209 and compatible with the tape wrapping system shall then be applied for each layer of white tape that has been removed.

3. When the damaged area shows a holiday when tested, the white outer layers shall be removed and the black inner wrap, Polyken No. 989-20 exposed. The exposed area and overlaps shall then be primed with a light coat of 927 primer. A patch of inner wrap of sufficient size to extend 4-in from the holidays in all directions shall then be firmly pressed into place. The patch shall then be holiday tested to determine that it is satisfactory. The outer layer of white tape shall then be retrimmed to expose the first wrap of white tape sufficiently to allow a minimum lap of 2-in in all directions. The exposed white tape shall

then be washed with xylol and primed. Two layers of outer wrap with a minimum thickness of 35 mils and conforming to AWWA C209 shall then be applied.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

A. Piping and fittings shall be installed in accordance with referenced standards, including the referenced AWWA manual, unless modified herein, true to alignment and supports, anchorage and thrust restraints shall be provided where required. If any defective pipe is discovered after it has been installed it shall be removed and replaced with a sound pipe in a satisfactory manner. Each length of pipe shall be cleaned out before installation.

B. Sleeves shall be installed of proper size for pipes passing through floors or walls as shown on the drawings. Sleeves shall be given a prime coat of rust inhibitive primer such Tnemec Series 10, or an approved equal as manufactured by Carboline.

C. Grade pipe to drain.

D. When cutting of pipe is required and acceptable to the OWNER, the cutting shall be done by machine in a neat workmanlike manner without damage to the pipe. Cut ends shall be smooth and at right angle to the axis of the pipe and lining and coatings repaired.

E. Earthwork shall be as specified in Division 2.

3.02 CONNECTION OF PIPE JOINTS

A. Welded

1. Field welding shall be in accordance with the American Welding Society Standards performed by welders certified under the provisions of AWS D1.1. Welding and welder qualifications shall also conform to the requirements of AWWA C206. The field weld shall develop the full yield strength of the pipe.

2. Welds shall be full-fillet, full circumference, double/single lap type or full circumference single V-groove butt type (where required) and shall be sound and free from embedded scale or slag, shall have tensile strength across the weld not less than that of the thinner of the connected sections, and shall be watertight. Field welds shall comply with AWWA C206.

3. Use butt welds for fabrication of bends and other specials. Use fillet welds for flange attachment in accordance with AWWA C207 modified for ANSI flanges where required. Flange attachment shall only be performed in the shop unless specifically approved in advance by the OWNER.

4. On bell-and-spigot and/or lap-welded slip joints, deflection may be taken at the joint by pulling a joint up to 3/4-in as long as the minimum lap requirements are maintained. Minimum lap requirements of assembled pipe will be 1-1/2-in or four times the thinner of the wall thickness being joined (whichever is greater) or will comply with AWWA C206, latest revision if more stringent. The bell end may be miter cut to take deflections up to 5 degrees as long as proper joint tolerances are maintained.

5. Welding rods shall be of type compatible with the metal to be welded to obtain the strongest bond E-60XX minimum.

6. During welding, the coating shall be protected by draping an 18-in wide strip of heat resistant material over the top half of the pipe on each side of the coating holdback to avoid damage to the coating by hot weld splatter. No welding ground shall be made on the coated part of the pipe.

7. Prior to welding, the pipes and pipe joints shall be properly positioned in the trench and backfilled sufficiently to prevent pipe movement (carefully avoiding the deposit of any backfill in the joints). Any tack welds used to position the pipe shall be removed and any annular space between the facing surfaces of the bell and spigot shall be equally distributed around the circumference of the joint. As welding progresses, the metal shall be deposited in successive layers so that there will be at least two passes or beads in the completed welds. Not more than 1/4-in of metal shall be deposited on each pass. Each individual pass, including the final one, shall be thoroughly cleaned by wire brushing and/or hammering to remove dirt, slag, or flux. Automatic welds shall provide a single pass 3/8-in fillet weld that fully develops the strength of the adjacent joints of pipe.

8. Preheating procedures for both lap and fillet welds shall be adhered to as stated in AWWA C206 and particular attention will be given to proper head control for pipe of wall thicknesses exceeding 1/2-in.

9. Welding shall not be performed under any weather condition that would impair the strength of the weld, such as wet surface, rain or snow, dust or high winds, unless the work is properly protected and the appropriate preheating is performed.

10. Tests of compliance with the specifications shall be made on each joint of pipe as soon as practical after completion of the joint welding. The Contractor shall employ an AWS-certified welding inspector certified in accordance with AWS QCI with a minimum of 3 years experience. Welded joints shall receive visual inspection by the certified welding inspector prior to performance testing. Test procedures for welded joints shall be as follows:

    a. Double welded lap joints/Single welded lap joints with seal weld - Double welded lap and single lap with seal weld joints shall be drilled and tapped for air pressure testing based on the procedures documented in AWWA C206. A threaded plug shall be installed through the lap or bell end of the pipe to introduce pressure between the two joint fillet welds. Air pressure shall be brought up gradually to a test pressure of 40 psi and maintained for 10 minutes. Any leaks found at lower pressures and the test pressure will be repaired. If defective, defective welds shall be removed, repaired, and retested until the joint passes the performance test. The OWNER will have the full and final decision as to the suitability of welds tests. Note: Hydrostatic testing for the entire pipeline is also required in paragraph 3.05.

    b. Butt welded joints - Completed butt welds shall be tested using a vacuum box test. The vacuum box shall be constructed of a sealed plastic cover (box) with an open bottom of the same curvature as the interior surface of the pipe. The open bottom shall be sealed against the pipe surface by a closed cell foam rubber gasket. A partial vacuum of less than 10-in of mercury shall be achieved when testing the weld. A soap solution shall be used on the test section and bubbles escaping from the joint will be

marked for repair. Following repair, the joint shall be retested until passed. Note: Hydrostatic testing for the entire pipeline is also required in paragraph 3.05.

C. Flanged.

1. Tighten flange bolts so gasket is uniformly compressed and sealed. Do not distort flanges. Do not over torque flange bolts to achieve seal and follow procedures in AWWA M-11 (Chapter 12).

2. Leave flange bolts with ends projecting approximately 1/2-in beyond face of nut after tightening.

D. Pipe ends, linings, and coatings.

1. After installation of pipe, fittings, and specials, unlined or uncoated ends adjacent to welded field joints, including the weld proper, shall be cleaned, primed, and lined and coated as specified for the pipe adjacent to the weld.

2. Preparation of surfaces to be lined and coated shall be as stipulated for shop application of coal tar primers and enamels in AWWA C203 except that foreign matter, including damaged lining or coating materials, shall be removed by scraping, chipping, or brushing and the surfaces cleaned to bright metal free of rust, slag, and scale by means of wire brushing or sandblasting.

3. Entry for application of interior linings to unlined ends shall be from open ends. Pour holes will not be allowed.

4. Linings shall be made continuous across joints. For 24-in diameter and larger this may be performed manually. For smaller pipe special methods and equipment will be required, as acceptable to the OWNER. Where cement mortar linings are applicable, the entire joint shall be wetted and the interior concrete mortar allowed to absorb the moisture. A curing agent as recommended by the mortar manufacturer shall also be employed subsequent to application.

6. Field joints shall be wrapped in accordance with AWWA C209. The joints shall be cleaned, primed and wrapped with two wraps of tape with a 35 mil thickness each and holiday tested. An acceptable 70 mil thickness shrink wrap sleeve in accordance with AWWA C216 may used in lieu of field tape.

7. Any damage to the pipe or the protective coating from any cause during the installation of the pipeline shall be repaired and holiday tested as acceptable to the OWNER.

8. Pipe shall be sound and clean before laying. When laying is not in progress for any period exceeding two hours and at the end of the work day, the open ends of the pipe shall be closed by watertight plug or other approved means. Good alignment shall be preserved in laying. The deflections at joints shall not exceed that recommended by the manufacturer. Fittings, in addition to those shown on the drawings, shall be provided as necessary.

E. Bell and Spigot Joints (including O-ring, where allowed, and welded lap joint pipe)

1. The pipe manufacturer shall furnish information and assist in the installation of at least the first five joints installed by the Contractor. Bedding of pipe shall conform to the requirements of the pipe earthwork sections noted in Paragraph 1.02. Blocking under the pipe will not be permitted during installation. Care shall be taken to prevent flotation of the pipe in the trench.

2. Each section of pipe shall be installed in the order and position shown on the laying schedule and shall be set to the line and grade with a maximum tolerance of 1-in plus or minus. This minimum tolerance shall be adhered to at any point based on a comparison with the calculated line and grade shown on the drawings or established in the field by the OWNER. Tolerances for shallow slopes will be more stringent as determined by the OWNER to ensure uniform slope to drain.

3. If necessary to raise or lower pipe due to unforeseen obstructions or other causes, the OWNER may change the alignment, slope, and grade. Changes shall be made by the deflection of joints, adapters, or by use of additional fittings. In no case shall the deflection in the joint exceed the maximum deflection recommended by the pipe manufacturer (as measured prior to application of repair mortar linings).

4. Except for short runs or closures, pipes shall be installed uphill on grades exceeding 10 percent. If pipe must be laid on a downhill grade, piping shall be properly blocked and held in place until sufficient support is provided by the following pipe to prevent movement.

5. As soon as the excavation is completed to the bottom of the excavation, place granular fill in the trench. The pipe shall then be firmly bedded in this gravel to conform to the line and grade indicated on the drawings. The granular fill shall be placed and compacted as specified in Section (02221) (31 23 33) and as shown on the bedding details included in the Drawings. Blocking under the pipe will not be permitted.

6. Before the pipe is lowered into the trench, the spigot and bell shall be cleaned and free from dirt. A depression shall be left in the supporting bedding at the joint to prevent contamination of the rubber gasket immediately before being forced home and to permit wrapping, testing and visual inspection of the entire joint. The pipe shall be properly aligned in the trench to avoid any possibility of contact with the side of the trench and fouling prior to welding. Gaskets and bell (where used) shall be lubricated by a vegetable lubricant (non-soluble in water) furnished by the manufacturer and harmless to the rubber gasket.

7. As soon as the spigot is centered in the bell of the previously installed pipe, it shall be forced home using a means approved by the OWNER (see paragraph 1.03). After the gasket is compressed and before the pipe is brought fully home, each gasket shall be carefully checked for proper position around the full circumference of the joint. The pipe shall be held in place or shall be anchored sufficiently back along the pipeline (a minimum of five lengths) so that the pulling force will not dislodge the pieces of pipe already in place.

8. As soon as the pipe is in place and before releasing force on the pipe holding it in place, pipe bedding shall be placed and compacted for at least one-half the length of pipe. Not

until this bedding is placed shall the forces be released. If any motion at joints can be detected, a greater amount of backfill shall be placed before pressure is released.

9. The Contractor shall carefully regulate his equipment and construction operations such that the loading of the pipe does not exceed the loads for which the pipe is designed and manufactured. Any pipe damaged during construction operations shall promptly and satisfactorily be repaired or removed and replaced at the Contractor's expense.

10. No pipe shall be installed upon a foundation into which frost has penetrated or at any time that there is a danger of the formation of ice or penetration of frost at the bottom of the excavation. No pipe shall be laid unless it can be established that the trench will be backfilled before the formation of ice and frost occurs.

11. Bell and spigot, lap joints, or butt joints subject to welding shall be welded in accordance with paragraph 3.02A.

12. Unwelded pipe joints shall be electrically bonded using bonding wire and brazing cartridges furnished by the pipe manufacturer in accordance with the details shown on the Drawings.

F. Other connections - per manufacturer of couplings' requirements, or for other ends, in compliance with applicable standard specifications, or if none exist, as acceptable to the OWNER.

3.03 INSTALLATION - SPECIFICS

A. Piping

1. Piping Layout.

a. Install as shown on the Drawings, per fabricator's shop drawings, and in accordance with the applicable specifications including the referenced AWWA manual.

b. In placing the pipe, hold pipe by one or more padded slings. Handle in a manner that will prevent damage to the pipe or the protective coating. Support pipe adequately while being fitted and joined with adjoining pipe section.

c. After each section of pipe has been set into position, attach to the adjoining section as specified or shown on the Drawings.

2. Provide drains and high point vents to facilitate pressure testing.

3. Install valves with operator positioned to permit access for operation.

3.04 CONNECTIONS TO STRUCTURES

A. Wherever a pipe 3-in in diameter or larger passes from concrete to earth horizontally, a minimum of two flexible joints spaced 3-ft on center apart shall be installed within 2-ft of the exterior face of the wall, whether or not shown on the drawings. Acceptable flexible joints shall be restrained mechanical joint, restrained mechanical sleeve coupling, Victaulic Depend-O-Lok F x F or approved equal.

B. Wall pipes or wall sleeves shall have a thrust ring collar located at mid-depth of wall.

3.05 FIELD TESTING

A. After installation, the pipe shall be tested for compliance as specified herein. Furnish necessary equipment and labor for the pressure test and leakage test on the pipelines.

B. Submit detailed test procedures and method for OWNER's review at least 10 days before starting the test. In general, testing shall be conducted in accordance with AWWA C600. A minimum of 24 hours notice to the OWNER is required prior to conducting pressure and leakage tests.

C. Electrical Continuity

1. Furnish necessary equipment and labor for carrying out a continuity check of the pipeline. This check shall be conducted prior to introduction of water into the pipeline for hydrostatic pressure and leakage testing. See Section 16640.

D. Pressure pipelines shall be subjected to a hydrostatic test pressure as stated in paragraph 2.03. This test pressure shall be maintained for a minimum of 2 hours. The leakage rate shall not exceed those indicated in AWWA C600 (see paragraph 3.06 K). Provide suitable restrained bulkheads as required to complete the hydrostatic testing specified. The test shall be made after backfilling. Connections shall be tested with the main as far as is practicable.

E. Valves shall be properly located and installed and operable prior to testing. In-line isolation valves shall be pressure tested in the open position. Bulkheads shall be provided with a sufficient number of outlets for filling and draining the line and for venting air.

F. Furnish gauges, meters, pressure pumps, and other equipment needed to fill the line slowly and perform the required hydrostatic pressure leakage tests.

G. The OWNER will be able to provide a limited source of supply for Contractor's use in filling the lines at locations where the new pipeline is connected to OWNER's system and where pipeline can be filled using gravity head available from OWNER's system. At other locations, the Contractor is responsible for obtaining, disposing, and paying for the necessary test water.

H. The line shall be slowly filled with water at a rate acceptable to the OWNER and air shall be vented from the line. The specified test pressure shall be maintained in the pipe for the entire test period by means of a pump furnished by the Contractor. Provide accurate means for measuring the quantity of water required to maintain this pressure. The amount of water required is a measure of the leakage. While the test section is under test pressure, a visual inspection for leaks shall be made along the pipeline, and visible leaks repaired. The pressure test shall not begin until the pipe has been filled with water for at least 24 hours to allow for absorption in the cement mortar linings.

I. Duration of pressure test shall not be less than 2 hours. The leakage test shall be a separate test following the pressure test and shall not be less than 2 hours duration. Leaks evident at the surface shall be repaired and leakage eliminated regardless of the total leakage as shown by test. Lines that fail to meet tests shall be repaired and retested as necessary until test requirements are complied with. Defective materials, pipes, valves, and accessories shall be removed and replaced.

J. Leakage Test

1. Leakage test shall be made after pressure test has been satisfactorily completed and backfilling and compaction is completed to top of trench. Furnish the necessary apparatus and assistance to conduct the test.

2. To pass the leakage test, the leakage from the pipeline shall not exceed the leakage allowed by the following formula:

$$L = \frac{ND\sqrt{P}}{3700}$$

in which

L = allowable leakage in gallons per hour.

N = number of joints in the pipeline being tested, this "N" being the standard joint length of the pipe furnished divided into the length being tested, with no allowance for joints at branches, blowoff, fittings, etc.

D = nominal diameter of pipe in inches.

P = average observed test pressure of the pipe being tested, equal to at least 100 percent of the class rating of pipe being tested, in pounds per square inch gauge, based on the elevation of the lowest point in the line or section under test and corrected to the elevation of the test gage.

3. Should the test on any section of the pipeline show leakage greater than specified above, locate and repair the defective pipe, fittings, or joint until the leakage is within the specified allowance of two hour duration. Repairs and retests, if required, shall be made at no additional cost to the OWNER.

3.06 CLEANING AND CHLORINATION

A. Chlorination of Pipelines

1. Before being placed in service, new recycled water pipelines shall be chlorinated using the continuous feed method specified in AWWA C651. The procedure shall be approved by the OWNER in advance.

2. The location of the chlorination and sampling points will be determined by the OWNER in the field. Taps for chlorination and sampling shall be installed. Uncover and backfill the taps as required.

3. The general procedure for chlorination shall be first to flush dirty or discolored water from the lines and then introduce chlorine in approved dosages through a tap at one end, while water is being withdrawn at the other end of the line. The chlorine solution shall remain in the pipeline for 24 hours.

4. Following the chlorination period, treated water shall be flushed from the lines at their extremities and replaced with potable water. Treated water flushed from the lines shall be disposed of by discharging to the nearest sanitary sewer or by other approved means. No discharge to any storm sewer or natural water course will be allowed. Bacteriological

sampling and analysis of the replacement water may then be made by the OWNER in full accordance with AWWA C651. Rechlorinate, if necessary and the line shall not be placed in service until the requirements of the State Public Health Department are met.

5. Special disinfecting procedures shall be used in connections to existing pipelines and where the method outlined above is not practical.

B. At the conclusion of the laying, and prior to testing, thoroughly clean all of the new pipelines by spraying with water or other means to remove dirt, stones, wood struts, pieces of wood, or other material that may have entered during the construction period. Debris cleaned from the lines shall be removed at construction access manholes or access ports. If, after this cleaning, obstructions remain, they shall be removed.

C. After the pipelines are cleaned and if the groundwater level is above the pipe, or following a heavy rain, the OWNER will examine the pipe for leaks. If defective pipes or joints are discovered at this time, they shall be repaired or replaced.

END OF SECTION

SECTION 02622

POLYVINYL CHLORIDE (PVC) PRESSURE PIPE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Installation and testing of polyvinyl chloride (PVC) recycled water pipe and fittings.

B. Pipe or piping refers to pipe, fittings, material and appurtenances required to construct PVC recycled water pipe complete, in place.

1.02 RELATED WORK

A. Trenching, backfilling and compacting is included in Section 02221.

B. Earthwork is included in Section 02200.

C. Pavement repair and resurfacing are included in Section 02576.

D. Precast concrete structures are included in Section 02605.

E. Ductile iron fittings are included in Section 02616.

F. Valves and appurtenances are included in Section 02640.

G. Loaming and seeding is included in Section 02930.

1.03 SUBMITTALS

A. The name of the pipe and fitting manufacturers and a list of materials to be furnished by each manufacturer. Also, include information on local representative for each manufacturer, if product is sold through a distributor.

B. Shop Drawings including piping layouts and schedules shall include dimensioning, fittings, types and locations of valves and appurtenances, joint details, methods and location of supports, anchorage, gasket material, grade of material and other pertinent technical information for items to be furnished.

C. Prior to each shipment of pipe, certified test reports that the pipe for this Contract was manufactured and tested in accordance with the ASTM and AWWA Standards specified herein shall be submitted.

D. Submit letters, shop drawings and product data showing installation equipment and details of installation for the Fusible PVC operation including:

1. Submit documentation showing the Fusible PVC fusion technician is qualified.

E. Provide manufacturers' certifications.

F. Hydrostatic pressure test plan.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.

2. ASTM D2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).

3. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

4. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

B. American Water Works Association (AWWA)

1. AWWA C110 - Ductile-Iron and Gray-Iron Fittings, 3-in Through 48-in (75mm Through 1219mm) for Water.

2. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

3. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.

4. AWWA C-605 – Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water.

5. AWWA C651 - Disinfecting Water Mains.

6. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4-in through 12-in for Water Distribution.

7. AWWA C905 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings 14-in through 48-in for Water Transmission and Distribution.

8. AWWA M-23 – Manual of Water Supply Practices PVC Pipe, Design and Installation.

C. National Sanitation Foundation (NSF)

1. Standard No. 14 - Plastic Piping Components and Related Materials.

2. Standard No. 61 - Drinking Water System Components - Health Effects.

1.05 QUALITY ASSURANCE

A. PVC recycled water pipe shall be from a single manufacturer. The supplier shall be responsible for the provisions of test requirements specified in ASTM D3034 and NSF Standard No. 14 as applicable. In addition, PVC pipe to be installed under this Contract may be inspected at the

plant for compliance with this Section by an independent testing laboratory provided by the OWNER. The Contractor shall require the manufacturer's cooperation in these inspections. The cost of plant inspection of pipe approved for this Contract, plus the cost of inspection of a reasonable amount of disapproved pipe, will be borne by the OWNER.

B. Inspections of the pipe may also be made by the OWNER or other representatives of the OWNER after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the requirements specified herein, even though sample pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall be removed from the job at once.

1.06 SYSTEM DESCRIPTION

A. The equipment and materials specified herein are intended to be of standard types for use in transporting recycled water.

B. Note information in pipe schedule on Drawings, if any and in this Section, especially concerning pressures, minimum thickness, and dimension ratio. In case of a conflict, information given in the pipe schedule shall govern.

C. CONTRACTOR is responsible for compatibility between pipe materials, fittings and appurtenances.

D. Unless otherwise noted, PVC pipe systems shall be designed for the following condition(s).

1. Class: 150 (DR 25)

2. System: AWWA C905

3. Pressure:

a. Operating: 150

b. Testing: 225

1.07 DELIVERY, STORAGE AND HANDLING

A. Items shall be bundled or packaged in such a manner as to provide adequate protection of the ends during transportation to the site. Any pipe damaged in shipment shall be replaced as directed by the OWNER.

B. PVC items deteriorate in sunlight and are slightly brittle, especially at lower temperatures, so care shall be taken in loading, transporting and unloading items to prevent injury to the items. Items shall be examined before installation and no piece shall be installed which is found to be defective. Handling and installation of pipe and fittings shall be in accordance with the manufacturer's instructions, referenced standards and as specified herein.

C. Any pipe or fitting showing a crack or which has received a blow that may have caused an incident fracture, even though no such fracture can be seen, shall be marked as rejected and removed at once from the work.

D. Any gouges or scratches that extend 10 percent or more into the pipe wall shall be cause for rejection of that pipe. The undamaged portion may be cut off and used. Rejected materials shall be clearly marked as rejected, segregated and removed from the site.

E. While stored, pipe shall be adequately supported from below at not more than 3-ft intervals to prevent deformation. The pipe shall be stored in stacks no higher than that given in the following table:

Pipe Diameter (inches)	Max. No. of Rows Stacked
8 or less	5
12 to 21	4
24 to 30	3
33 to 48	2

F. Pipe and fittings shall be stored in a manner which will keep them at ambient outdoor temperatures and out of the sunlight. Temporary shading as required to meet this requirement shall be provided. Simple covering of the pipe and fittings which allows temperature buildup or direct or indirect sunlight will not be permitted.

G. If any defective item is discovered after it has been installed, it shall be removed and replaced with an exact replacement item in a satisfactory manner by the CONTRACTOR, at the CONTRACTOR's own expense. Pipe and fittings shall be thoroughly cleaned before installation and the interior shall be kept clean until testing

H. In handling the items, use special devices and methods as required to achieve the results specified herein. No uncushioned devices shall be used in handling the item.

PART 2 PRODUCTS

2.01 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

A. PVC pressure pipe sized 4 through 12-in shall conform to the requirements of AWWA C900. Piping shall be Class 150 with a Dimension Ratio of 25. The pipe shall be PVC 1120 made from PVC compounds Class 12454-A or 12454-B as defined in ASTM D1784. Each pipe length shall be marked with the manufacturer's name or trademark, size, material code, pressure class, AWWA designation number and seal of test agency that verified pipe material for potable-water service.

B. PVC pressure pipe sizes 14 through 48-in shall conform to the requirements of AWWA C905. The pipe shall be made from PVC compounds Class 12454-A or 12454-B as defined in ASTM D1784. Each pipe length shall be marked with the manufacturer's name or trademark, size, material code, pressure class, AWWA reference and seal of test agency that verified pipe material for potable-water service.

C. Fittings for water mains shall be cast or ductile iron conforming to AWWA C110 for mechanical joints. Adaptors, fittings and transition gaskets necessary to connect cast or ductile iron fittings to PVC shall be furnished.

D. Recycled water pipe shall be purple in color.

2.02 FUSIBLE POLYVINYL CHLORIDE (FPVC)

A. Piping and Fittings: Pipe, AWWA C905. Fittings shall be the same as specified for PVC pipe. Fusible polyvinyl chloride pipe for non-potable water not conforming to AWWA C905 dimensionality shall conform to AWWA C900, ASTM D2241 or ASTM D1785 for standard dimensionality, as applicable. Testing shall be in accordance with the referenced AWWA standards. Unless otherwise specified, fusible polyvinyl chloride pipe lengths shall be assembled in the field with butt-fused joints. The fusion technician shall follow the pipe supplier's guidelines for this procedure. Fusion joints shall be completed as described in this specification. Fusible polyvinyl chloride pipe shall be purple in color for non-potable use.

PART 3 EXECUTION

3.01 INSTALLATION OF PVC PIPE AND FITTINGS

A. No single piece of pipe shall be laid unless it is straight. The centerline of the pipe shall not deviate from a straight line drawn between the centers of the openings at the ends of the pipe by more than 1/16-in per foot of length. If a piece of pipe fails to meet this requirement, check for straightness, it shall be rejected and removed from the site. Laying instructions of the manufacturer shall be explicitly followed.

B. If any defective pipe is discovered after it has been installed, it shall be removed and replaced with a sound pipe in a satisfactory manner at no additional cost to the OWNER. Pipe and fittings shall be thoroughly cleaned before installation, shall be kept clean until they are used in the work and when laid, shall conform to the lines and grades required. PVC pipe and fittings shall be installed in accordance with requirements of the manufacturer, ASTM D2321 and AWWA C605 or as otherwise provided herein.

C. As soon as the excavation is complete to normal grade of the bottom of the trench, bedding shall be placed, compacted and graded to provide firm, uniform and continuous support for the pipe. Bell holes shall be excavated so that only the barrel of the pipe bears upon the bedding. The pipe shall be laid accurately to the lines and grades indicated on the Drawings. Blocking under the pipe will not be permitted. Bedding shall be placed evenly on each side of the pipe to mid-diameter and hand tools shall be used to force the bedding under the haunches of the pipe and into the bell holes to give firm continuous support for the pipe. Bedding shall then be placed to 12-in above the top of the pipe. The initial 3-ft of backfill above the bedding shall be placed in 8-inch layers and carefully compacted. Generally the compaction shall be done evenly on each side of the pipe and compaction equipment shall not be operated directly over the pipe until sufficient backfill has been placed to ensure that such compaction equipment will not have a damaging effect on the pipe. Equipment used in compacting the initial 3-ft of backfill shall be approved by the pipe manufacturer's representative prior to use.

D. Piping shall be sound and clean before installation. When installation is not in progress, including lunchtime, the open ends of the pipe shall be closed by watertight plug or other approved means. Good alignment shall be preserved during installation. The deflection at joints shall not exceed that recommended by manufacturer. Fittings, in addition to those shown on the Drawings, shall be provided, if required, in crossing utilities that may be encountered upon opening the trench.

E. When cutting pipe is required, the cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe. Cut ends of pipe to be used with a bell shall be beveled to conform

to the manufactured spigot end and a reference mark made at the same distance from the pipe end as measured from a factory marked end from the same manufacturer.

F. The OWNER may examine each bell and spigot end to determine whether any preformed joint has been damaged prior to installation. Any pipe having defective joint surfaces shall be rejected, marked as such and immediately removed from the job site.

G. Each length of the pipe shall have the assembly mark aligned with the pipe previously laid and held securely until enough backfill has been placed to hold the pipe in place. Joints shall not be "pulled" or "cramped".

H. Before any joint is made, the pipe shall be checked to assure that a close joint with the next adjoining pipe has been maintained and that the inverts are matched and conform to the required grade. The pipe shall not be driven down to grade by striking it.

I. Precautions shall be taken to prevent flotation of the pipe in the trench.

J. When moveable trench bracing such as trench boxes, moveable sheeting, shoring or plates are used to support the sides of the trench, care shall be taken in placing and moving the boxes or supporting bracing to prevent movement of the pipe, or disturbance of the pipe bedding and the backfill. Trench boxes, moveable sheeting, shoring or plates shall not be allowed to extend below top of the pipe. As trench boxes, moveable sheeting, shoring or plates are moved, pipe bedding shall be placed to fill any voids created and the backfill shall be recompacted to provide uniform side support for the pipe.

K. Restrained joints shall be installed for joints at fittings and in restrained joint areas as shown on the drawings. Where a pipe connects to a fitting, the first segment of pipe on both sides of the fitting shall be a full stick of pipe. Provide restrained joints at pipeline angle points and deflections and as shown. Joint restraints shall be as follows:

1. Fully restrain all bell joints using Romac Industries Inc. “GripRing”, CertainTeed “Certa-Loc C-900/RJ”, or approved equal.

2. Fully restrain all mechanical joints using JCM “Model 610 Sur-Grip Fitting Restrainer”, EBBA Iron “Series 2000 PV” or approved equal.

3.02 JOINTING PVC PIPE (Push-on type)

A. Joints shall be made in strict accordance with the manufacturer's instructions. Pipe shall be laid with bell ends towards the laying direction. A rubber gasket shall be inserted in the groove of the bell end of the pipe and the joint surfaces cleaned and an approved lubricant applied in accordance with the manufacturer’s recommendations. The plain end of the pipe to be installed shall then be inserted into the bell of the pipe to which it is to be joined and when in alignment pushed home with a come-along or by other means. Check that the reference mark on the spigot end is flush with the end of the bell.

3.03 JOINTING MECHANICAL JOINT FITTINGS

A. Mechanical joints at valves, fittings and where designated shall be in accordance with the AWWA C111 and the instructions of the manufacturer. Suitable PVC to cast iron adaptors shall be installed prior to installing fittings. PVC beveled spigot shall be cut flush prior to

insertion in mechanical joint pipe. To assemble the joints in the field, thoroughly clean the joint surfaces and rubber gasket with soapy water before tightening the bolts. Bolts shall be tight to the specified torques. Under no condition shall extension wrenches or pipe over handle of ordinary ratchet wrench be used to secure greater leverage.

3.04 INSTALLATION FUSIBLE POLYVINYLCHLORIDE (FPVC) PRESSURE PIPING

A. Installation guidelines from the pipe supplier shall be followed for installations. Fusible polyvinylchloride pipe will be handled in a safe and non-destructive manner before, during, and after the fusion process and in accordance with this specification and pipe supplier's guidelines. The fusible polyvinylchloride pipe will be installed in a manner so as not to exceed the recommended bending radius guidelines. Where fusible polyvinylchloride pipe is installed by pulling in tension, the recommended maximum safe pulling force, established by the pipe supplier, shall not be exceeded. The general best practices of the industry per AWWA M23 shall also be observed.

B. Fusible polyvinylchloride pipe will be fused by qualified fusion technicians holding current qualification credentials for the pipe size being fused, as documented by the pipe supplier. Pipe supplier’s procedures shall be followed during fusion operations. Each fusion joint shall be recorded and logged by an approved electronic monitoring device (data logger) connected to the fusion machine, which utilizes a current version of the pipe supplier’s recommended and compatible software. Only appropriately sized and outfitted fusion machines that have been approved by the pipe supplier shall be used for the fusion process. This includes requirements for safety, maintenance, and operation with modifications made for PVC.

C. Maximum offset in alignment between adjacent pipe joints shall be as recommended by the manufacturer and approved by the Contracting Officer, but shall not exceed 5 degrees.

D. Fused joints are restrained joints. Fusible PVC may be used in areas where restrained fittings are indicated without additional restraint at fused joints.

E. Install fittings in accordance with AWWA C605.

3.05 FILLING AND TESTING

A. After installation, the pipe shall be tested for compliance as specified herein. Furnish necessary equipment and labor for the hydrostatic pressure test on the pipelines.

B. Submit detailed test procedures and method for OWNER's review. In general, testing shall be conducted in accordance with AWWA C605. The method and procedures for the hydrostatic pressure test shall be approved by the OWNER. Submit the plan for testing to the OWNER at least 10 days before starting a test.

C. Pressure pipelines shall be subjected to a hydrostatic pressure in accordance with paragraph 1.06-D. This test pressure shall be maintained for a minimum of 2 hours. The hydrostatic testing allowances shall not exceed those indicated in AWWA C605. Provide suitable restrained bulkheads as required to complete the hydrostatic testing specified.

D. CONTRACTOR shall make any taps and furnish necessary caps, plugs, or other items as may be required in conjunction with performing the testing.

E. Valves and valve boxes shall be properly located and installed and operable prior to testing. Bulkheads shall be provided with a sufficient number of outlets for filling and draining the line and for venting air.

F. Hydrostatic pressure tests shall conform to Section 7.3 of AWWA C605. Furnish gauges, meters, pressure pumps and other equipment needed to fill the line slowly and perform the required hydrostatic pressure tests.

G. The line shall be slowly filled with water and the specified test pressure shall be maintained in the pipe for the entire test period by means of a pump furnished by the CONTRACTOR. Provide accurate means for measuring the quantity of makeup water required to maintain this pressure.

H. Duration of pressure test shall not be less than 2 hours. Leaks evident at the surface shall be repaired and leakage eliminated regardless of the total leakage as shown by test. Lines which fail to meet tests shall be repaired and retested as necessary until test requirements are complied with. Defective materials, pipes, valves and accessories shall be removed and replaced.

3.06 CLEANING PIPELINES

A. Furnish necessary equipment and labor for cleaning the pipelines. The procedures and methods shall be approved by the OWNER.

1. As pipe laying progresses and at the conclusion of the work thoroughly clean new pipelines by flushing with water or other means to remove dirt, stones, pieces of wood or other material which may have entered during the construction period. If, after this cleaning, obstructions remain, they shall be removed.

END OF SECTION

SECTION 02623

HIGH DENSITY POLYETHYLENE PIPE AND FITTINGS (PRESSURE PIPE)

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Installation of high density polyethylene (HDPE) pipe and fittings.

1.02 RELATED WORK

A. Dewatering and drainage are included in Section 02140.

B. Trenching, backfilling and compaction are included in Section 02221.

C. Horizontal directional drilling is included in Section 02158.

D. Concrete for thrust blocks in included in Division 3.

1.03 SUBMITTALS

A. Submit completely detailed shop drawings and schedules of high density polyethylene (HDPE) pipe and fittings required.

B. Submit the name and address of pipe manufacturer.

C. Submit complete description of method of pipe installation.

D. Submit description of the method of testing the pipe and fittings including a complete drawing of mandrel with dimensions for each pipe size.

F. Submit the manufacturer’s recommendations for handling, storing and installing the pipe and fittings.

G. Submit certification that the stress regression testing has been performed on the specific polyethylene resin being utilized in the manufacturing of the pipe for this contract in accordance with ASTM D2837.

H. Prior to each shipment, submit certified test reports that the pipe and fittings for this contract were manufactured and tested in accordance with the ASTM and AWWA Standards specified herein.

I. Submit documentation showing the fusion technician is qualified.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewer and Other Gravity-Flow Applications.

2. ASTM D2774 – Standard Practice for Underground Installation of Thermoplastic Pressure Piping.

3. ASTM D2657 - Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings.

4. ASTM D2837 - Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.

5. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.

6. ASTM F714 - Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.

B. American Water Works Association (AWWA)

1. AWWA C600 - Installation of Ductile Iron Water Mains and Their Appurtenances.

2. AWWA C906 - Polyethylene (PE) Pressure Pipe and Fittings, 4-in Through 63-in, for Water Distribution and Transmission.

C. American National Standards Institute (ANSI)

1. ANSI B16.1 - Cast Iron Flanges and Flanged Fittings.

2. ANSI B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.

3. ANSI/NSF 61- Drinking Water System Components-Health Effects

1.05 DELIVERY, STORAGE AND HANDLING

A. The delivery, storage and handling of the pipe and fittings shall be done in accordance with the manufacturer’s recommendations.

B. Pipe shall be stored on clean, level ground to prevent any scratching or gouging of the pipe. The handling of the pipe shall be done in a manner to avoid dragging the pipe over any hard or sharp objects to avoid cutting of the pipe’s exterior. Any cut or gouge deeper than 5 percent of the pipe’s wall thickness shall be removed from the site.

C. Handling of the pipe shall be done in a manner to avoid undue stress in the pipe caused by bending of the pipe.

D The interior of the pipe shall be free of cuts, gouges and scratches.

1.06 QUALITY ASSURANCE

A. HDPE pipe and fittings shall be manufactured in strict accordance with ASTM F714, AWWA C906 and shall be from a single manufacturer. HDPE pipe and fittings shall be supplied by a single distributor. Pipe and fittings shall be NSF 61 approved.

B. Pipes under this contract shall be manufactured from a polyethylene resin that has been specifically stress regression tested to provide a product supplying a minimum Hydrostatic Design Basis (HDB) of 1600 psi, as determined in accordance with ASTM D2837.

C. HDPE pipe to be installed under this Contract may be inspected at the factory for compliance with this Section by an independent testing laboratory provided by the OWNER. The manufacturer's cooperation shall be required in these inspections. The cost of these plant inspections of pipe approved for this Contract will be borne by the OWNER.

D. Inspection of the pipe may also be made by the OWNER or other representatives of the OWNER after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the specified requirements, even though pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall immediately be removed from the job.

PART 2 PRODUCTS

2.01 MATERIALS

A. General

1. HDPE pipe is a flexible conduit and shall be designed to transfer imposed loads to the surrounding embedment medium. The pipe and fittings shall be free from defects including indentations, delaminations, cracks, bubbles and pinholes, which due to their nature, degree, or extent, detrimentally affect the strength and serviceability of the pipe. Any pipe or fittings with such defects which, in the judgement of the OWNER, will affect the strength and serviceability shall be repaired or rejected.

2. HDPE pipe resins shall be high molecular weight, high density polyethylene with a cell classification number of 345464C (or E) or higher cell classification in accordance with ASTM D3350.

B. Pipe and Fittings

1. The pipes shall have the nominal dimensions shown on the Drawings. Pipe shall meet the requirements of Dimension Ratio (DR) 9 and have a minimum pressure rating of 200 psi.

2. Polyethylene pipes shall meet the requirements of ASTM F714 and AWWA C906. Pipe and fittings shall be NSF 61 approved.

3. Pipe shall be furnished in standard laying lengths not exceeding 50-ft.

4. Joining system: The pipe shall be joined with butt, heat fusion joints. Joints shall be made in strict compliance with the manufacturer's recommendations and ASTM 2657. Where

required, flange connections, mechanical joint connections and butt connections using bolted mechanical couplers shall be provided from a pipe stub with a polyethylene and steel stiffener. Flanged connections shall be provided from a pipe stub and a steel back-up flanged. Back-up flanges shall be primed and painted in a corrosion protected paint recommended and supplied by the manufacturer. Bolts, nuts and hardware shall be Type 316 stainless steel.

5. HDPE fittings shall be fully pressure rated to match the pipe DR pressure rating. Fittings shall be molded or fabricated by the same manufacturer as the pipe. HDPE fittings shall be joined using butt, heat fusion and/or electrofusion. Adhesives and solvent cements shall not be permitted.

2.02 PIPE IDENTIFICATION

A. At 5-ft intervals along the pipe, the pipe shall be marked with the name of the manufacturer, size and class (pressure and DR), and manufacturing reference to ASTM F714 and AWWA C906.

B. A color coded strip(s) shall be marked along the entire length of the pipe.

PART 3 EXECUTION

3.01 INSTALLATION

A. Pipe and fittings shall be installed in accordance with the manufacturer's instructions.

B. The CONTRACTOR performing the joining shall be by a distributor of the pipe material supplied. Fusion joints shall be done by a factory qualified technician.

C. Joining of the pipe by heat fusion shall be done in accordance with ASTM D2657. Prior to the start of pipe installation, one test joint shall be made and tested. Test shall be done in accordance with CPChem Co. Bulletin No. 106. No joints shall be made until a successful test joint has been made.

D. When cutting pipe is required, the cutting shall be done by machine specifically designed for the cutting of HDPE pipe. The cut shall leave a smooth cut at right angles to the axis of the pipe.

E. Fittings shall be connected to HDPE pipe in accordance with manufacturer's recommendations.

F. Flanged and mechanical connections shall consist of the following:

1. A high density polyethylene flange adapter, made by the manufacturer from the same resin as the pipe, and fully pressure rated to match the pipe DR pressure rating, thermally butt-fused to the stub end of the pipe.

2. A ductile iron or steel back-up ring conforming to ANSI B16.1 fitted to the polyethylene flange adapter and shaped as necessary to suit the outside dimension of the pipe.

3. A full face neoprene gasket, conforming to ANSI B16.21.

4. Corrosion resistant bolts and nuts of Type 316 stainless steel as specified in ASTM A276 and ASTM A307. Bolts shall be tightened alternatively and evenly to the manufacturer's specified torques. After installation a bitumastic coating shall be applied to bolts and nuts.

E. Tracer wire shall be installed on HDPE pipe prior to HDD installation.

3.02 CLEANING AND TESTING

A. Furnish necessary equipment and labor for cleaning and testing the pipelines. The procedures and methods shall be approved by the OWNER.

B. Make any taps and furnish necessary caps, plugs, etc, as required in conjunction with testing pipelines. Furnish a test pump, gauges and any other equipment required in conjunction with carrying out the hydrostatic tests.

C. Cleaning Pipelines

1. As pipe laying progresses and at the conclusion of the work thoroughly clean new pipelines by flushing with water or other means to remove dirt, stones, pieces of wood or other material which may have entered during the construction period. If, after this cleaning, obstructions remain, they shall be removed.

D. Testing Pressure Pipelines

1. Pressure pipelines shall be pressure and leakage tested. Pipelines shall be subjected to a hydrostatic pressure of 50 percent above the normal operating pressure and this pressure maintained for at least 10 minutes. The leakage test shall be conducted at the maximum operating pressure as determined by the OWNER, and this pressure shall be maintained for at least two hours. The test pump and water supply shall be arranged to allow accurate measurement of the water required to maintain the test pressure. The amount of leakage which will be permitted shall be in accordance with AWWA C600.

END OF SECTION

SECTION 02640

VALVES AND APPURTENANCES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Buried valves, valves and meters in manholes and underground vaults, and appurtenances complete with actuators and accessories.

1.02 RELATED WORK

A. Trenching, Backfilling, and Compaction are included in Section 02221.

B. Earthwork is included in Section 02200.

C. Concrete is included in Division 3.

D. Miscellaneous Metal Fabrication is included in Section 05500.

E. Surface Preparation and Shop Painting are included in Section 09901.

F. Cathodic Protection is included in Section 13110.

1.03 SUBMITTALS

A. Submit materials required to establish compliance with this Section for shop drawings. Submittals shall include the following:

1. Manufacturer's literature, illustrations, specifications and engineering data including:

a. Dimensions.

b. Size.

c. Materials of construction.

d. Weight.

e. Protection coating.

f. Actuator weight.

g. Calculations for actuator torque where applicable.

B. Test Reports

1. Certified shop test results specified herein.

C. Operation and Maintenance Manuals

1. Submit complete installation, operation, and maintenance manuals including copies of approved Shop Drawings.

D. Certificates

1. Certificates of compliance where required by referenced standards: For each valve specified to be manufactured and/or installed in accordance with AWWA and other standards, submit an affidavit of compliance with the appropriate standards, including certified results of required tests and certification of proper installation.

1.04 REFERENCE STANDARDS

A. Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.

B. American Water Works Association (AWWA)

1. AWWA C110 – Ductile-Iron and Gray-Iron Fittings

2. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron and Pressure Pipe and Fittings.

3. AWWA C500 - Metal-Seated Gate Valves for Water Supply Service.

4. AWWA C504 - Rubber-Seated Butterfly Valves.

5. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service.

6. AWWA C515 - Reduced Wall, Resilient-Seated Gate Valves for Water Supply Service

7. AWWA C517 – Resilient-Seated Cast Iron Eccentric Plug Valves

8. AWWA C800 – Underground Service Lines and Fittings

D. American Society for Testing and Materials (ASTM)

1. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

2. ASTM A536 - Standard Specification for Ductile Iron Castings.

E. The Society for Protective Coatings (SSPC)

1. SSPC SP-6 - Joint Surface Standard Commercial Blast Cleaning

1.05 QUALITY ASSURANCE

A. Manufacturer's Qualifications

1. Valves and appurtenances provided under this Section shall be the standard product in regular production by manufacturers whose products have proven reliable in similar service for at least 10 years. If required, the manufacturer shall furnish evidence of installation in satisfactory operation.

2. Units of the same type shall be the product of one manufacturer.

B. Design Criteria

1. Valves and appurtenances shall be new and in perfect working condition. Valves shall be designed for continuous use with a minimum of maintenance and service required and shall perform the required function without exceeding the safe limits for stress, strain or vibration. In no case will used or damaged valves be acceptable. The selection of equipment to meet the specified design conditions is the responsibility of the CONTRACTOR. Both workmanship and material shall be of the very best quality and shall be entirely suitable for the service conditions specified.

C. Source Quality Control

1. Valves shall be shop tested in accordance with the following:

a. Metal-seated gate valves: AWWA C500.

b. Rubber-seated butterfly valves: AWWA C504.

c. Resilient-seated gate valves: AWWA C509.

d. Reduced-wall, resilient-seated gate valves: AWWA C515.

2. Obtain each type of valve from no more than one manufacturer.

1.06 SYSTEM DESCRIPTION

A. General

1. Current project includes 10,750 LF of 18-inch and 3,250 LF of 24-inch Recycled Water Transmission Pipeline.

1.07 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site to ensure uninterrupted progress of the work.

B. Protect threads and seats from corrosion and damage. Rising stems and exposed stem valves shall be coated with a protective oil film which shall be maintained until time of use.

C. Furnish covers for openings.

1. Valves 3-in and larger shall be shipped and stored on site until time of use with wood or plywood covers on each valve end.

2. Butterfly valves shall be delivered with blind flanges bolted in place until valve is pressure-tested on site, before installation and burial.

D. Store equipment to permit easy access for inspection and identification. Any corrosion in evidence at the time of OWNER acceptance shall be removed, or the valve shall be removed from the job.

E. Store equipment in covered storage off the ground.

1.08 COORDINATION

A. Review installation procedures under other Sections and coordinate with the work which is related to this Section including buried piping installation, and site utilities.

B. Coordinate the location and placement of concrete thrust blocks when required.

PART 2 PRODUCTS

2.01 GENERAL

A. Buried valves shall open counter-clockwise.

B. The use of a manufacturer's name and/or model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.

C. Valves shall be of the size shown on the Drawings or as noted and as far as possible equipment of the same type shall be identical and from one manufacturer.

D. Valves shall have the name of the maker, nominal size, flow directional arrows, working pressure for which they are designed and standard to which they are manufactured cast in raised letters on some appropriate part of the body.

E. Unless otherwise noted, valves shall have a minimum working pressure of 150 psi or be of the same working pressure as the pipe they connect to, whichever is higher, and suitable for the pressures noted where they are installed.

F. Valves shall be of the same nominal diameter as the pipe or fittings they are connected to. Except as otherwise noted, joints shall be mechanical joints, with joint restraint where the adjacent piping is required to be restrained.

G. Valves shall be constructed for buried service.

2.02 VALVE BOXES

A. Gate, butterfly and plug valves shall be provided with extension shafts, operating nuts and valve boxes as follows:

1. Extension shafts shall be 3” diameter schedule 40 steel pipe and the operating nut shall be 2-in square. Shafts shall be designed to provide a factor of safety of not less than four. Operating nuts shall be pinned to the shafts.

2. Top of the operating nut shall be located 2-in below the rim of the valve box.

3. Valve boxes shall be Christy No G12 or equal and shall be a heavy-pattern cast iron, three-piece, telescoping type box with dome base suitable for installation on the buried valves. Inside diameter shall be at least 4-1/2-in. Barrel length shall be adapted to the depth of cover, with a lap of at least 6-in when in the most extended position. Covers shall be cast iron with integrally-cast direction-to-open arrow, and the word “SVCSD RECYCLED WATER 2012” shall also be integrally cast. Aluminum or plastic are not acceptable, as the box and lid must be traffic H20 rated. A means of lateral support for the valve extension shafts shall be provided in the top portion of the valve box.

4. The upper section of each box shall have a top flange of sufficient bearing area to prevent settling. The bottom of the lower section shall enclose the stuffing box and operating nut of the valve and shall be oval.

5. A position-indicating device shall be provided for each gate and butterfly valve. The position-indicating device shall be GPI Series Geared Position Indicator by Dyna-Torque Inc., Muskegon, MI or equal, which shall mount over the shaft and visually show the position of the valve. Material shall be non-corrosive, nonmagnetic and shall require no lubrication. Unit shall be furnished and arranged for use with the valve box. The required valve box adapters and cover shall be furnished.

6. An approved operating key or wrench shall be furnished.

7. Fasteners shall be Type 316 stainless steel.

8. Gate or plug valves located at turnouts shall have locking lid.

2.03 METER BOXES

A. Propeller Meters located at turnouts shall be provided with meter boxes and lids.

1. Meter box shall be reinforced concrete in material. Meter box shall be Christy B1324 or equal. Box shall be H20 traffic rated.

2. Meter box lid shall be steel checker plate and have a 5” x 8” reading lid. Lid shall be Christy B1324-51GH or equal. Lid shall be H20 traffic rated.

2.04 RESILIENT WEDGE GATE VALVES

A. General

1. Gate valves shall conform to the requirements of AWWA C509, except as may be specifically modified herein.

2. Valves 3-in and larger shall be iron body, bronze mounted.

B. Gate valves 3-in and larger

1. Valves shall be double disc-type with 150 psig working pressure rating with a minimum non-shock rating of 200 psig.

2. Buried valves shall have non-rising stems, mechanical joint ends and 2-in square operating nuts. Valves shall be furnished with O-ring seals.

3. Furnish valves and accessories as manufactured by one of the following:

a. Henry Pratt Company

b. DeZurik Corporation

c. Or approved equal

2.05 TAPPING SLEEVES AND TAPPING VALVES

A. Tapping sleeves shall be of stainless steel, designated for working pressure not less than 200 psi. Armored end gaskets shall be provided for the full area of the sleeve flanges. Sleeves shall be as manufactured by A.P. Smith Division of U.S. Pipe; Mueller; Clow or equal. Nuts and bolts shall be Type 304 or Type 316 stainless steel.

B. Tapping valves shall conform to the requirements specified above for gate valves except that one end shall be flanged and one mechanical. Tapping valves shall be provided with an oversized opening to permit the use of full size cutters.

2.06 RUBBER-SEATED BUTTERFLY VALVES

A. Valves shall be manufactured in strict accordance with AWWA C504. Valves shall be bubble tight at rated pressures. Valve discs shall rotate 90 degrees from full closed to open. Operators shall be assembled to the valve by the valve manufacturer. The valve/operator shall be tested as a complete assembly by the valve manufacturer. The manufacturer shall have produced AWWA butterfly valves for a minimum of 5 years.

B. Valve bodies shall be constructed of cast iron ASTM A126, Class B. Valves in vaults shall be flanged. Flange drilling shall be in accordance with ANSI B16.1, Class 150. Laying length shall be short body as listed in AWWA C504. Buried valves shall be mechanical joint end conforming to ANSI C111.

C. Valve discs shall be constructed of cast iron ASTM A126 or A48, ductile iron ASTM A536. Material mating with the seat shall be either Type 304 or Type 316 stainless steel.

D. Rubber valve seats shall be Buna-N, Buna-S, or EPDM. If the seat is on the disc it shall be mechanically retained by Type 304 stainless steel fasteners. If the seat is in the valve body and seat retaining hardware such as screws and segments are used they shall be monel. If screws are used, monel plugs shall be affixed in the valve body and tapped to receive these screws.

E. Valve shafts shall be Type 304 stainless steel, ASTM A276 and shall be of a diameter not less than those listed in AWWA C504, Class 150B.

F. Shaft seals shall be furnished where the shaft projects thru the valve body. Shaft seals shall be standard split-v type packing or of an O-ring design.

G. Valves shall be fitted with sleeve type bearings contained in the trunions of the valve body. Bearing material shall be nylon for valves thru 20-in and fiberglass with teflon lining for valves 24-in and larger.

H. Valve manufacturer shall furnish and mount operator suitable for buried service. Operators shall be self-locking and suitable for submergence to 20-ft. A 2-in square operating nut shall be furnished. Operator stops shall be capable of withstanding an input of 450 ft-lbs.

I. Valves shall be hydrostatically and leak tested.

J. Valve class shall be AWWA Class 150B with operators sized for bi-directional flow.

K. Valves shall be manufactured by Henry Pratt Company; DeZurik Corporation; or approved equal.

2.07 AIR RELEASE AND VACUUM RELIEF VALVES:

A. Valves shall be supplied with shutoff gate or ball valves with operator handle or lever in place. Valves shall be properly vented and piped to drain.

B. Valve pressure rating shall be at least 250 psi or equal to the attached pipeline rating.

C. Combination Air and Vacuum Relief Valves: Tag Type CAV

1. Valves shall be manufactured by Vent-O-Mat RBX 2531.

D. Vacuum Relief and Air Release Valves: Tag Type VR/AR

1. Valves shall be APCO S-1500C with S-200A, Cla Val Series 38 VR/AR.

2. These valves shall have 3” inlet orifice and a maximum outlet orifice of 0.5”.

2.08 CHECK VALVES

A. Check valves for 4-inch and larger diameter pipelines shall be swing type and shall meet the material requirements of AWWA C508. The valves shall be iron body, bronze mounted, single disc, matching or exceeding pipeline working pressure, non-shock and hydrostatically tested at 300 psi. Ends shall be 125 lb ANSI B16.1 flanges.

1. When there is no flow through the line the disc shall hang lightly against its seat in practically a vertical position. When open, the disc shall swing clear of the waterway.

2. Check valves shall have bronze seat and body rings, extended bronze hinge pins and bronze nuts on the bolts of bolted covers.

3. Valves shall be so constructed that disc and body seat may easily be removed and replaced without removing the valve from the line. Valves shall be fitted with an extended hinge arm

with outside lever and spring. Springs with various tensions shall be provided and springs approved by the OWNER shall be installed.

4. Check valves shall have bronze seat and body rings, bronze or ductile clapper arm and bronze nuts on the bolts of bolted covers. Shaft assembly and key shall be A582 type 416 stainless steel. Hinge shaft shall extend from the body of the valve, sealed with stuffing box, packing and gland. Shaft side plug bearing, stuffing box and gland shall be bronze, packing shall be reinforced Teflon, both side plug and stuffing box shall be provided with grease fittings.

5. Check valves shall be manufactured by Henry Pratt; DeZurik; or approved equal.

2.09 PLUG VALVES

A. Plug valves specified herein shall be suitable for buried service, and shall be DeZurik Corporation; Henry Pratt Company; or approved equal. Plug valves shall conform to the minimum requirements of AWWA C517, in addition to the requirements specified herein.

B. All plug valves shall be of the non-lubricated, eccentric type with bodies and plugs of semi-steel construction. Valves shall be rated for a minimum working pressure of 175 psig for 3-in through 12-in and 150 psig for 14-in through 72-in valves. Valves up to and including 20-inch in size shall have an unobstructed port area of not less than 80 percent of full pipe area, and not less than 70 percent for larger valves. All valves shall open by turning the wrench nut counter-clockwise.

C. All plug valves for recycled water service, shall be capable of passing "pigging" cleaning equipment (using a Girard or similar cleaning pig of full nominal pipeline diameter) in either direction and manufacturer shall so certify that this may be done without the use of special equipment.

D. Valves shall have balanced plugs with a resilient facing of Nitrile (Buna-N) solidly bonded thereto to assure bubble-tight shutoff low torque requirements.

E. Seats shall have a welded-in overlay of 90 percent pure nickel on all surfaces contacting the plug face.

F. Valves shall be furnished with bolted bonnets and self-adjusting chevron-type packing. Packing shall be replaceable without disassembling the valve or removing the bonnet from the valve.

G. Corrosion-resistant, permanently-lubricated bearings shall be provided at both ends of the valve shafts.

H. All valves shall be supplied with flange ends conforming to AWWA C110, unless otherwise noted herein.

I. All exterior hardware on valves shall be of Type 316 stainless steel.

2.10 ELECTRONIC CONTROL VALVES

A. The Electronic Control Valve shall control flow. The valve shall be a hydraulically operated, pilot controlled, diaphragm valve. The solenoid pilot controls are to be actuated by electrical signals

from the 131VC-1 Electronic Valve Controller. This valve shall be a Cla-Val, Model 18" 631-0BCENSVYKC or approved equal.

B. Material Specification
Valve Size: 18" Reduced Port
Main Valve Body and Cover: 631
Main Valve Trim: Stainless Steel
End Detail: Flanged
Pressure Rating: 250 psi
Temperature Range: 40 to 70 °F
Rubber Material: Buna – N
Coating: Epoxy
Desired Options: Isolation Valve (Option B), CV Flow Control (Option C), CV Flow Control (Option S), X43 Strainer (Option Y), Position Transmitter (Option E), Electronic Controller (Option N), Visual Position Indicator (Option V), Epoxy Lining (Option KC)

C. Pilot Control System- the hydraulic control valve pilot system shall consist of dual solenoids which alternately apply or relieve pressure to the diaphragm chamber to position the main valve. They shall be normally closed (energized to open), 120 volt AC with Nema type 6 enclosure. A manual system to by-pass the solenoids shall also be provided.

D. The Model 131VC controller shall provide the interface between a remote computer system and the hydraulic control valve. It shall be powered by 120 volt AC and installed in a NEMA 4X enclosure. It shall have remote communication capability in analog format. Local manual set-point and emergency manual control shall also be provided. The controller shall accept an analog 4-20 mA setpoint feedback signal from the RTU.

E. A direct factory representative shall be made available for start-up service, inspection and necessary adjustments.

2.11 FLOW METERS

A. The flow meter located at the BP-B1 vault shall be a vortex shedding insertion flow meter, designed to be installed in the inlet tapping of a Cla-Val Automatic Control Valve to provide accurate flow measurement data. The flow meter shall be Cla-Val, Model X144 e-Flow Meter or approved equal.

1. Provides flow data with accuracy +/- 2% of Full Scale

2. 4-20mA Loop Powered

3. Stainless Steel Construction

4. The flow meter's power requirement shall be 12/24 VDC, 0.7 watts minimum.

5. The flow meter shall be IP-68 submersible.

6. The flow meter shall be warranted to be free of defects in material and workmanship for a period of one year from date of shipment, provided it is installed and used in accordance with all applicable instructions.

B. The flow meters located at turnouts shall be a propeller flow meter. The meter shall have be designed for a working pressure of 150 psi. The accuracy of the meter shall be +/- 2% for the entire flow range. The meter flow tube shall be coated with fusion- bonded epoxy for corrosion protection. The meter shall come with a flow rate indicator and a 6-digit totalizer. The flow meters shall be McCrometer Propeller MW500.

2.12 SURFACE PREPARATION AND SHOP COATINGS

A. The interior ferrous metal surfaces, except finished or bearing surfaces, shall be blast cleaned in accordance with SSPC SP-10 and painted with two coats of an approved two-component epoxy coating specifically formulated for potable water use. The coating shall be NSF certified to Standard 61.

B. Exterior ferrous metal surfaces of buried valves shall be blast cleaned in accordance with SSPC SP-6 and given two shop coats of approved two-component coal tar epoxy paint.

C. Exterior ferrous metal surfaces of non-buried valves shall be shop painted with one coat of primer in accordance with the requirements of Section 09901.

2.13 PROTECTIVE WRAPPING FOR BURIED METALLIC ITEMS

A. The wax tape protective wrapping for flanged joints, flexible or mechanical couplings, flanged coupling adapters, valves, special areas and other exposed appurtenances and joints below final grade shall be protected by a primer, mastic, wrapping, and overwrapping system, Denso, Trenton, or equal.

PART 3 EXECUTION

3.01 INSPECTION AND PREPARATION

A. During installation of valves and appurtenances, verify that items are clean, free of defects in material and workmanship and function properly.

B. Valves shall be closed and kept closed until otherwise directed by the OWNER.

3.02 INSTALLATION OF BURIED VALVES AND VALVE BOXES

A. Buried valves shall be cleaned and manually operated before installation. Buried valves and valve boxes shall be set with the stem vertically aligned in the center of the valve box. Valves shall be set on a firm foundation and supported by tamping pipe bedding material under the sides of the valve. The valve box shall be supported during backfilling and maintained in vertical alignment with the top flush with finish grade. The valve box shall be set so as not to transmit traffic loads to the valve.

B. Before backfilling, exposed portions of any bolts shall be coated with two coats of bituminous paint.

C. Install valve floor stand operators with stainless steel bolts.

D. Protective Wrapping: Apply protective wrapping to all exposed metal appurtenances and joints below final grade in accordance with the manufacturer's written instructions. Apply primer to all surfaces. Fill void areas with mastic to produce a uniform surface for subsequent tape wrapping.

3.03 INSTALLATION OF TAPPING SLEEVES AND VALVES

A. The proper authority shall be contacted and their permission granted prior to tapping a "live" line. The required procedures and time table shall be followed exactly.

B. Installation shall be made under pressure and flow shall be maintained. The diameters of the tap shall be not less than 1/4-in less than the inside diameter of the branch line.

C. The entire operation shall be conducted by workers experienced in the installation of tapping sleeves and valves. The tapping machine shall be furnished by the CONTRACTOR.

D. Determine the location of the line to be tapped to confirm that the proposed location will be satisfactory and that no interference will be encountered such as joints or fittings. No tap or sleeve will be made closer than three feet from a pipe joint.

E. Tapping sleeve and valve with boxes shall be set squarely centered on the line to be tapped. Adequate support shall be provided under the sleeve and valve during the tapping operation. Thrust blocks or other permanent restraint acceptable to the OWNER shall be provided behind tapping sleeves. Proper tamping of supporting pipe bedding material around and under the valve and sleeve is mandatory for buried installations.

F. After completing the tap, the valve shall be flushed to ensure that the valve seat is clean. Proper regulatory procedures (including disinfection) shall be followed exactly.

3.04 FIELD TESTS AND ADJUSTMENTS

A. Conduct a functional field test of each valve, including actuators and valve control equipment, in presence of OWNER to demonstrate that each part and components together function correctly. Testing equipment required shall be furnished by the CONTRACTOR.

3.05 MANUFACTURER'S SERVICE

A. Furnish the services of a qualified representative of the tapping equipment manufacturer to provide on-site instruction during wet tapping of the existing water mains indicated on the Drawings.

B. Following installation of the valves, furnish the services of a qualified, factory-trained representative of the manufacturer of the respective valves, to check the installations before they are placed in operation, supervise initial operations and testing in the presence of the OWNER, instruct the plant personnel in care and maintenance of the equipment, and make necessary field adjustments. A minimum of one 8-hour day shall be provided for these services. In the event of trouble with the equipment, the representative of the respective manufacturer shall revisit the site as often as necessary until troubles are corrected and the installation is entirely satisfactory.

END OF SECTION

SECTION 02901

MISCELLANEOUS WORK AND CLEANUP

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Performing the miscellaneous work not specified in other sections but obviously necessary for the proper completion of the work.

B. The work of this Section includes, but is not limited to, the following:

1. Crossing and relocating existing utilities.
2. Restoring driveways and sidewalks.
3. Cleaning up.
4. Incidental work.
5. Job photographs.
6. Protection and/or removal and reinstallation of signs, lampposts and mailboxes.
7. Restoration and replacement of curbing.
8. Protection and bracing of utility poles.
9. Restoring easement and right-of-ways.
10. Temporary facilities.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials required for this Section shall be the same quality of materials that are to be restored. Where possible, re-use existing materials that are removed.

PART 3 EXECUTION

3.01 CROSSING AND RELOCATING EXISTING UTILITIES

A. Perform any work required in crossing culverts, water courses, including brooks and drainage ditches, storm drains, gas mains, water mains, electric, telephone, gas and water services and other utilities. This work shall include: bracing, hand excavation, backfill (except screened gravel) and any other work required for crossing the utility or obstruction. Notification of Utility Companies shall be as specified in Division 1.

B. In locations where existing utilities cannot be crossed without interfering with the construction of the work as shown on the Drawings, remove and relocate the utility as directed by the OWNER or cooperate with the Utility Companies or private owners concerned if they relocate their own utility.

C. At pipe crossings and where designated by the OWNER, furnish and place CDF or CLSM in the pipe zone and pipe bedding areas, so that the existing utility or pipe is firmly supported for its entire exposed length. The CDF or CLSM shall extend to the spring line of the existing utility or pipe crossed.

3.02 RESTORING DRIVEWAYS AND SIDEWALKS

A. Existing public and private driveways disturbed by the construction shall be replaced. Paved drives shall be repaved to the limits and thicknesses existing prior to construction. Gravel drives shall be replaced and regraded in kind.

B. Existing public and private sidewalks disturbed by the construction shall be replaced with sidewalks of equal quality and dimension.

3.03 CLEANING UP

A. Remove construction material, excess excavation, buildings, equipment and other debris remaining on the job as a result of construction operations and restore the site of the work to a neat and orderly condition.

3.04 INCIDENTAL WORK

A. Do incidental work not otherwise specified, but obviously necessary to the proper completion of the work as shown on the Drawings and as specified herein.

3.05 PHOTOGRAPHS OF PROJECT

A. Prior to the excavation in any street or cross country area, document existing conditions using construction photographs.

B. The photographs shall be retained in a secure location throughout the duration of the project and shall then be turned over to the OWNER.

C. At the conclusion of Work, document the existing conditions using construction photographs with attention paid to the direction and orientation of photographs taken under Paragraph A.

3.06 REMOVAL AND REPLACEMENT OF SIGNS, LAMPPOSTS AND MAILBOXES

A. Existing signs, lampposts and mailboxes which may be damaged or removed during the course of installing the new pipelines shall be reinstalled in a vertical position at the same location from which they were removed. Replace damaged items with items of equal or better quality than the damaged items. Provide a concrete anchor as necessary, to ensure a rigid alignment. Exercise care in the reinstallation of items to prevent damage to the newly installed pipelines.

3.07 RESTORATION AND REPLACEMENT OF CURBING

A. Existing concrete, bituminous, timber or granite curbing shall be protected. If necessary, curbing shall be removed and replaced after backfilling. Curbing which is damaged during construction shall be replaced with curbing of equal quality and dimension at the CONTRACTOR's expense. Granite curbing removed and reset shall conform to the corresponding Caltrans standard. Joints between sections shall be pointed as required after resetting. Bituminous berms shall conform to the corresponding Caltrans standard.

3.08 COOPERATION WITH OTHER CONTRACTORS AND CONNECTION TO WORK BY OTHERS

A. Construction on other contracts may be carried on during the same period as construction under this Contract. It will be necessary for the CONTRACTOR to plan his/her work and cooperate with the other contractor insofar as connections required to each other's work and to prevent any interference and delay.

3.09 PROTECTION AND BRACING OF UTILITY POLES

A. Make arrangements with the proper utility companies for bracing and protection of utility poles that may be damaged or endangered by the operations. Work shall include the related removal and reinstallation of guy wires, or support poles whether shown on the Drawings or not.

3.10 RESTORING EASEMENTS AND RIGHT-OF-WAYS

A. Be responsible for damage to private property due to the operations. Protect from injury walls, fences, cultivated shrubbery and vegetables, fruit trees, grape vines, pavement, underground facilities, such as water pipe, or other utilities which may be encountered along the route. If removal and replacement are required, it shall be done in a workmanlike manner so that replacement is equivalent to that which existed prior to construction.

B. Existing lawn and sod surfaces damaged by construction shall be replaced. Cut and replace the lawn and sod, or restore the areas with an equivalent depth and quality of loam, seed and fertilizer as necessary to produce a stand of grass at least equal to that existing prior to construction. These areas shall be maintained and reseeded, if necessary, until work under this Contract has been completed and accepted. Any additional work required to restore property to the original condition shall be performed.

C. Existing trees, shrubs, plants, grape vines and bushes outside of easements shall be fully protected. The work shall also include removing and replacing those trees, shrubs, grape vines and bushes as indicated on the Drawings. It shall include the careful excavation of the root ball which shall be wrapped with burlap while out of the ground. Replant them after backfilling the trench, stake them in an upright position and shall periodically water replanted trees, bushes and shrubs. Be fully responsible for ensuring that trees, bushes and shrubs removed and replanted, "take" and return to a viable state. Any replanted item that fails to "take" or that is so damaged as to be unsuitable for replanting shall be replaced, at no additional cost to the OWNER, with a tree, bush, grape vine or shrub equal to the one removed.

D. The OWNER will inspect work for provisional acceptance upon the written request received at least 10 days before the anticipated date of inspection.

1. After necessary corrective work has been completed, the OWNER will certify in writing the provisional acceptance of the planting.

E. Plants shall be guaranteed for not less than 1 full year from the time of provisional acceptance.

1. At the end of this period, any plant that is missing, dead, or not in satisfactory growth, as determined by the OWNER, shall be replaced.

2. Replacements shall be plants of the same kind and size. They shall be furnished and planted as specified herein. The cost of replacement shall be borne by the CONTRACTOR except where it can be definitely shown that loss resulted from vandalism or the OWNER's failure to maintain planting as instructed.

3. At the end of the guarantee period, inspection will be made by the OWNER upon written request submitted by the landscape contractor at least 10 days before the anticipated date.

4. After necessary corrective work has been completed and tree staking has been removed, the OWNER will certify in writing the final acceptance of the planting.

3.11 TEMPORARY FACILITIES

A. Furnish, install, maintain and remove temporary facilities required for construction or called for in this Section.

END OF SECTION

SECTION 02930

LOAMING AND SEEDING

PART 1 GENERAL

1.01 SECTION INCLUDS

A. Placing loam, finish grade, applying lime and fertilizer, hydraulically applying seed and mulch and maintaining all seeded areas, including areas disturbed and existing lawn areas.

1.02 RELATED WORK

A. Site Preparation is included in Section 02100.

B. Earthwork is included in Section 02200.

1.03 SUBMITTALS

A. Submit complete shop drawings, materials and equipment furnished under this Section including seed mixtures and product label information.

B. Samples of materials shall be submitted for inspection and acceptance.

PART 2 PRODUCTS

2.01 MATERIALS

A. Loam shall be fertile, natural soil, typical of the locality, free from large stones, roots, sticks, clay, peat, weeds and sod and obtained from naturally well drained areas. It shall not be excessively acid or alkaline nor contain toxic material harmful to plant growth. Topsoil stockpiled under other Sections of this Division may be used, but the CONTRACTOR shall furnish additional loam at his/her own expense if required.

B. Fertilizer shall be a complete commercial fertilizer, 10-10-10 grade for grass areas. It shall be delivered to the site in the original unopened containers each showing the manufacturer's guaranteed analysis. Store fertilizer so that when used it shall be dry and free flowing.

C. Lime shall be ground limestone containing not less than 85 percent calcium and magnesium carbonates.

D. Grass seed shall be from the same or previous year's crop; each variety of seed shall have a percentage of germination not less than 90, a percentage of purity not less than 85 and shall have not more than 1 percent weed content. The mixture shall consist of seed proportioned by weight as follows:

1. Durable Coarse Grass

   a. 70 percent KY-31 Tall Fescue (Festuca Arundinacea)

   b. 20 percent Kentucky Blue Grass (Poa Pratensis)

c. 10 percent Perennial Rye Grass (Lolium Perenne)

2. Coarse Lawn Grass

a. 45 percent KY-31 Tall Fescue (Festuca Arundinacea)

b. 20 percent Penlawn Red Fescue

c. 25 percent Kentucky Bluegrass

d. 10 percent Annual Rye Grass or mixed with Weeping Lovegrass depending upon the season

3. Fine Lawn Grass

a. 30 percent Merion Kentucky Blue Grass

b. 40 percent Kentucky Blue Grass

c. 20 percent Penlawn Red Fescue

d. 10 percent Annual Ryegrass

4. Field Grass I

a. 15 percent Smooth Broom

b. 15 percent Orchard Grass

c. 15 percent Timmothy

d. 15 percent Red Clover

e. 10 percent Sweet Clover

f. 10 percent Korean Lespedeza

g. 10 percent Interstate Sercia

h. 10 percent Lespedeza

5. Field Grass II

a. 4 -lbs of pure seed

b. Bachelor Button

c. Lance-Leaved Coreopsis

d. Babys Breath

e. Scarlet Flax

f. Purple Cone Flower

g. Evening Primrose

h. Baby Snapdragon

i. Calendula

j. Corn Poppy

k. Catchfly

l. Black-Eyed Susan

m. Lewis Flax

n. 26 lbs bulking agent-sheep fescue or equal northern mixture

E. The seed shall be furnished and delivered premixed in the proportions specified above. A manufacturer's certificate of compliance to the specified mixes shall be submitted by the manufacturer for each seed type. These certificates shall include the guaranteed percentages of purity, weed content and germination of the seed and also the net weight and date of shipment. No seed may be sown until the certificates have been submitted.

F. Mulch shall be a specially processed cellulose fiber containing no growth or germination-inhibiting factors. It shall be manufactured in such a manner that after addition and agitation in slurry tanks with water, the fibers in the material become uniformly suspended to form a homogeneous slurry. When sprayed on the ground, the material shall allow absorption and percolation of moisture. Each package of the cellulose fiber shall be marked by the manufacturer to show the air dry weight content.

PART 3 EXECUTION

3.01 APPLICATION

A. Unless otherwise shown on the Drawings, loam shall be placed to a minimum depth of 6-in on lawn areas and 4-in in areas indicated to be naturalized.

B. For areas to be seeded:

1. Lime shall be applied at the rate of 25 lbs/1,000 sq ft.

2. Fertilizer (10-10-10) shall be applied at the rate of 30 lbs/1,000 sq ft.

3. Lawn grass seed shall be applied at the rate of 10 lbs/1,000 sq ft. Field Grass I seed shall be applied at the rate of 4 lbs/1,000 sq ft. Field Grass II seed shall be applied at the rate of 5 lbs/acre sq ft.

4. Fiber mulch shall be applied at the rate of 20 lbs/1,000 sq ft.

C. The application of fertilizer and lime may be performed hydraulically in one operation with hydroseeding and mulching. If lime is applied in this manner, clean structures and paved areas of unwanted deposits.

3.02 INSTALLATION

A. The subgrade of areas to be loamed and seeded shall be raked and rubbish, sticks, roots and stones larger than 2-in shall be removed. Subgrade surfaces shall be raked or otherwise loosened immediately prior to being covered with loam. Subgrade shall be inspected and approved by the OWNER before loam is placed.

B. Loam shall be placed over approved areas to a depth sufficiently greater than required so that after natural settlement and light rolling, the complete work will conform to the lines, grades and elevations indicated. No loam shall be spread in water or while frozen or muddy.

C. After loam has been spread, it shall be carefully prepared by scarifying or harrowing and hand raking. Large stiff clods, lumps, brush, roots, stumps, litter and other foreign material shall be removed from the loamed area and disposed of. The areas shall also be free of smaller stones, in excessive quantities, as determined by the OWNER. The whole surface shall then be rolled with a hand roller weighing not more than 100 lbs/ft of width. During the rolling, depressions caused by settlement of rolling shall be filled with additional loam and the surface shall be regraded and rolled until a smooth and even finished grade is created.

D. Seeding, mulching and conditioning shall only be performed during those periods within the seasons which are normal for such work as determined by the weather and locally accepted practice, as approved by the OWNER. Hydroseed only on a calm day.

E. Areas with Field Grass II shall receive site preparation and be seeded according to the manufacturer's written instructions.

F. Schedules for seeding and fertilizing must be submitted to the OWNER for approval prior to the work.

G. If lime and fertilizer are to be spread mechanically rather than in one operation with the hydroseeding, then:

1. After the loam is placed and before it is raked to true lines and rolled, limestone shall be spread evenly over loam surface and thoroughly incorporated with loam by heavy raking to at least 1/2 the depth of loam.

2. Fertilizer shall be uniformly spread and immediately mixed with the upper 2-in of topsoil.

H. Seeding shall be done within 10 days following soil preparation. Seed shall be applied hydraulically at the rates and percentages indicated. The spraying equipment and mixture shall be so designed that when the mixture is sprayed over an area, the grass seed and mulch shall be equal in quantity to the specified rates. Prior to the start of work, the OWNER shall be furnished with a certified statement for approval as to the number of pounds of materials to be used per 100 gallons of water. This statement shall also specify the number of square feet of seeding that can be covered with the quantity of solution in the Hydroseeder.

I. In order to prevent unnecessary erosion of newly graded slopes and unnecessary siltation of drainage ways, carry out seeding and mulching as soon as satisfactory completion of a unit or portion of the project. A unit of the work will be defined as not more than 20,000 sq ft.

J. When protection of newly graded areas is necessary at a time that is outside of the normal seeding season, protect those areas by whatever means necessary (such as straw applied with a tar tack) or by other measures as approved by the OWNER.

3.03 SEEDING IN WOODED AND UNGRADED AREAS

A. For preparation and seeding in wooded areas under this Contract and where no grading is required, specified materials and procedures shall be utilized except that no disking shall be performed within the drip line of trees to be preserved. The seed bed shall be prepared by the addition of a thin layer of top soil roughly 1-in deep.

3.04 MAINTENANCE AND PROVISIONAL ACCEPTANCE

A. Keep seeded areas watered and in good condition, reseeding if and when necessary until a good, healthy, uniform growth is established over the entire area seeded and shall maintain these areas in an approved condition including a minimum of two mowings of the lawn areas until provisional acceptance.

B. On slopes, provide against washouts by an approved method. Any washout that occurs shall be regraded and reseeded at the CONTRACTOR's expense until a good sod is established.

C. The OWNER will inspect work for provisional acceptance at the end of the 8 week grass maintenance period, upon the written request, received at least 10 days before the anticipated date of inspection.

D. A satisfactory stand will be defined as a section of grass of 10,000 sq ft or larger that has:

1. No bare spots larger than 3 sq ft.

2. No more than 10 percent of total area with bare spots larger than 1 sq ft.

3. Not more than 15 percent of total area with bare spots larger than 6-in square.

E. Furnish full and complete written instructions for maintenance of the lawns to the OWNER at the time of provisional acceptance.

F. The inspection by the OWNER will determine whether maintenance shall continue in any area of manner.

G. After necessary corrective work and clean-up has been completed and maintenance instructions have been received by the OWNER, the OWNER will certify in writing the provisional acceptance of the lawn areas. Maintenance of lawns or parts of lawns shall cease on receipt of provisional acceptance.

3.05 GUARANTEE PERIOD AND FINAL ACCEPTANCE

A. Seeded areas shall be guaranteed for not less than 1 full year from the time of provisional acceptance.

B. At the end of the guarantee period, inspection will be made by the OWNER upon written request submitted at least 10 days before the anticipated date. Lawn areas not demonstrating satisfactory stands as outlined above, as determined by the OWNER, shall be renovated, reseeded and maintained meeting requirements as specified herein.

C. After necessary corrective work has been completed, the OWNER shall certify in writing the final acceptance of the lawns.

END OF SECTION

DIVISION 3

CONCRETE

SECTION 03100

CONCRETE FORMS AND ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Concrete forms.

2. Concrete form accessories.

1.02 RELATED WORK

A. Concrete Reinforcement is included in Section 03200.

B. Concrete Joints and Joint Accessories is included in Section 03250.

C. Cast-in-Place Concrete is included in Section 03300.

D. Grout is included in Section 03600.

E. Modifications and Repair to Concrete is included in Section 03922.

1.03 REFERENCES

A. American Concrete Institute (ACI):

1. ACI 301 - Specifications for Structural Concrete.

2. ACI 318 - Building Code Requirements for Structural Concrete.

3. ACI 347 – Guide to Formwork for Concrete.

B. American Plywood Association (APA):

1. Material grades and designations as specified.

1.04 DEFINITIONS

A. Architectural concrete is wall, slab, beam or column concrete which will have surfaces exposed to view in the finished work. It includes similar exposed surfaces in water containment structures from the top of walls to 2-ft below the normal water surface in open tanks and basins.

1.05 SYSTEM DESCRIPTION

A. Design Requirements:

1. Forms and shoring shall be designed at no additional cost to the OWNER by a professional Civil or Structural Engineer registered in the State of California.

2. Formwork shall be designed in accordance with the requirements of ACI 301 and ACI 318 and as recommended in ACI 347 and shall comply with all applicable regulations and codes.

3. The design shall consider any special requirements due to the use of plasticized and/or retarded set concrete.

B. Performance Requirements: Forms shall be designed and constructed to provide a flat, uniform concrete surface requiring minimal finishing or repairs. Form design shall accommodate all of the concrete mix designs being used by the CONTRACTOR.

1. Secure to forms as required or set for embedment as required, miscellaneous metal items, sleeves, reglets, anchor bolts, inserts and other items furnished under other Sections and required to be cast into concrete.

1.06 SUBMITTALS

A. Submit product data showing materials of construction for:

1. Form release agent

2. Form ties

3. Form liners

4. Bond breakers

B. Shop Drawings

1. Location and sequence of the concrete placements.

2. Review of pour sequence, form system and panel layout shall be for appearance, general compliance with the Drawing requirements and compatibility with other Submittals – including rebar placement and waterstop placement shop drawings.

C. Samples

1. The CONTRACTOR shall demonstrate to the OWNER on a designated area of the concrete substructure exterior surface that the form release agent will not adversely affect concrete surfaces to be painted, coated or otherwise finished and will not affect the forming materials. This demonstration shall include the application of these finishes in accordance with the requirements of the Contract Documents over areas of at least 16 square feet each.

D. Quality Assurance/Control

1. Certify that forms and shoring are designed by a professional Civil or Structural Engineer registered in the State of California.

PART 2 PRODUCTS

2.01 MATERIALS

A. Forms for cast-in-place concrete shall be made of wood, metal, or other approved material. Wood forms for architectural concrete and surfaces in contact with water shall be new and unused and new plywood shall be on such forms for each use. Construct wood forms of sound lumber or plywood of suitable dimensions and free from knotholes and loose knots. Where used for exposed surfaces, dress and match boards. Sand plywood smooth and fit adjacent panels with tight joints. Metal forms may be used when approved by the OWNER.

B. Wall Forms

1. At the start of Work on this Project, forms for exposed exterior and interior concrete walls and surfaces in contact with water shall be new and unused "Plyform" exterior grade plywood panels manufactured in compliance with the APA and bearing the trademark of that group, or equal. Provide B grade or better veneer on faces to be placed against concrete during forming. The class of material and grades of interior plies shall be of sufficient strength and stiffness to provide a flat, uniform concrete surface requiring minimal finishing and grinding. Forms may be re-used up to two times provided they are thoroughly cleaned, holes are neatly plugged, and the surface is satisfactory in the opinion of the OWNER.

2. Joints or gaps in forms shall be taped, gasketed, plugged, and/or caulked with an approved material so that the joint will remain watertight and will withstand placing pressures without bulging outward or creating surface patterns.

C. Column Forms

Not Used.

D. Rustications shall be at the location and shall conform to the details shown on the Drawings. Moldings for chamfers and rustications shall be milled and planed smooth. Rustications and corner strips shall be of a nonabsorbent material, compatible with the form surface and fully sealed on all sides to prohibit the loss of paste or water between the two surfaces.

E. Form Release Agent

1. Coat forming surfaces in contact with concrete which will not be painted, using an effective, non-staining, non-residual, water based, bond-breaking form coating unless otherwise noted.

F. Concrete surfaces which are to be painted shall be formed with hard plastic finished plywood or a similar material which does not require a form release agent unless the CONTRACTOR

can substantiate to the satisfaction of the OWNER that the form release agent will not remain on the formed surface after it is stripped.

G. Form Ties

1. Form ties encased in concrete shall be designed so that, after removal of the projecting part, no metal shall remain within 1-1/2-in of the face of the concrete. The part of the tie to be removed shall be at least 1/2-in diameter or be provided with a wood or plastic cone at least 1/2-in diameter and 1-1/2-in long. Form ties in concrete exposed to view shall be the cone-washer type.

2. Flat bar ties for panel forms shall have plastic or rubber inserts having a minimum depth of 1-1/2-in and sufficient dimensions to permit proper patching of the tie hole.

3. Ties for liquid containment structures and structures below finished grade shall have an integral waterstop that is welded to the tie. Tie rods with carbon content less than 0.25 percent shall be used for this application.

4. Common wire shall not be used for form ties.

5. In liquid containment structures and structures below finished grade, form tie systems other than those requiring integral waterstops may be used. As a minimum, the alternate system shall comply with the following:

a. Tapered through-bolts at least 1-in in diameter at smallest end or through-bolts that utilize a removable tapered sleeve of the same minimum size. The smallest end shall be located on the non-liquid bearing wall face.

b. Coat tapered rubber plug with epoxy bonding agent and insert 3-in from the non-liquid bearing wall face.

c. Fill both sides of taper tie hole with non-shrink cement grout.

d. Obtain OWNER's acceptance of system and spacing of ties prior to ordering or purchase of forming.

e. The CONTRACTOR shall be responsible for watertightness of the form ties and any repairs needed.

PART 3 EXECUTION

3.01 EXAMINATION

A. Not Used.

3.02 PREPARATION

A. Wood forms in contact with concrete which are not to be painted shall be coated with an effective release agent prior to form installation.

B. Steel forms shall be thoroughly cleaned and mill scale and other ferrous deposits shall be sandblasted or otherwise removed from the contact surface for forms, except those utilized for surfaces receiving a rough finish. Forms shall have the contact surfaces coated with a release agent unless they are to be painted.

3.03 INSTALLATION

A. General

1. Forms shall be used for cast-in-place concrete including sides of footings except for pipe and conduit encasements where concrete may be placed directly against the side of the trench. Forms shall be constructed and placed so that the resulting concrete will be of the shape, lines, dimensions and appearance indicated on the Drawings.

2. Molding, bevels, or other types of chamfer strips shall be placed to produce blockouts, rustications, or chamfers as shown on the Drawings or as specified herein. Chamfer strips shall be provided at horizontal and vertical projecting corners to produce a 3/4-in chamfer. Rectangular or trapezoidal moldings shall be placed in locations requiring sealants where specified or shown on the Drawings. Sizes of moldings shall conform to the sealants manufacturer's recommendations.

3. Forms shall be sufficiently rigid to withstand construction loads and vibration and to prevent displacement or sagging between supports. Construct forms so that the concrete will not be damaged by their removal. The CONTRACTOR shall be entirely responsible for the adequacy of the forming system.

4. Form material that is allowed to be reused in unexposed conditions shall have surfaces in contact with concrete thoroughly cleaned, damaged places repaired, projecting nails withdrawn and protrusions smoothed. Reuse of wooden forms for other than surfaces not exposed to view will not be permitted.

5. Metal items such as rebar, wire, or plates used to support pipe penetrations, and pipe embedments shall have minimum clearance of 1-inch from reinforcing steel bars.

B. Form Tolerances

1. Forms shall be surfaced, designed and constructed in accordance with the recommendations of ACI 347 and shall meet the following additional requirements for the specified finishes.

2. Formed Surface Exposed to View: Edges of form panels in contact with concrete shall be flush within 1/32-in and forms for plane surfaces shall be such that the concrete will be plane within 1/16-in in 4-ft. Forms shall be tight to prevent the passage of mortar, water and grout. The maximum deviation of the finish wall surface at any point shall not exceed 1/4-in from the intended surface as shown on the Drawings. Form panels shall be arranged symmetrically and in an orderly manner to minimize the number of seams.

3. Formed surfaces not exposed to view or buried shall meet requirements of Class "C" Surface in ACI 347.

4. Formed rough surfaces including mass concrete, pipe encasement, electrical duct encasement and other similar installations shall have no minimum requirements for surface smoothness and surface deflections. The overall dimensions of the concrete shall be plus or minus 1-in.

5. Formed Concrete Surfaces to Receive Paint: Surface deflections shall be limited to 1/32-in at any point and the variation in wall deflection shall not exceed 1/16-in per 4-ft. The maximum deviation of the finish wall surface at any point shall not exceed 1/4-in from the intended surface as shown on the Drawings.

6. All textured faces, form liners, or rustications to be exposed to view shall be straight, plumb and true with a variation of no more than 1/4-in in 10-ft measured in any direction.

C. Removal of Forms

1. The CONTRACTOR shall be responsible for damage resulting from removal of forms. Forms and shoring for structural slabs or beams shall remain in place in accordance with ACI 301 and ACI 347.

2. Except as otherwise specifically authorized by the OWNER, forms shall not be removed before the concrete has attained the following percentage of its specified design strength, nor before reaching the following time after completion of concrete placement (whichever is the longer):

TABLE 03100-1
MINIMUM TIME TO FORM REMOVAL

Forms for	Percentage of Specified Strength	Time after Placement
Sides of footings, grade beams, and encasements	--	12 hours with air temperature above 50°
Sides of walls	30	48 hours

3. Immediately following form removal, cure formed concrete surfaces in accordance with Section 03300.

4. Shores for elevated slabs and beams shall not be removed until the concrete has attained its specified design strength.

3.04 FIELD QUALITY CONTROL

A. Inspection

1. The OWNER shall be notified when the forms are complete and ready for inspection at least 12 hours prior to the proposed concrete placement.

2. CONTRACTOR shall ensure that metal pipeline embeds are separated from form ties and rebar by a minimum of 1-inch to keep pipelines electrically isolated.

3. Failure of the forms to comply with the requirements specified herein, or to produce concrete complying with requirements of this Section, shall be grounds for rejection of that portion of the concrete work. Rejected work shall be repaired or replaced as directed by the OWNER, at no additional cost to the OWNER. Such repair or replacement shall be subject to the requirements of this Section and Section 03922.

END OF SECTION

SECTION 03200

CONCRETE REINFORCEMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Concrete reinforcement.

1.02 RELATED WORK

A. Concrete Forms and Accessories is included in Section 03100.

B. Concrete Joints and Joint Accessories is included in Section 03250.

C. Cast-in-Place Concrete is included in Section 03300.

D. Grout is included in Section 03600.

E. Modifications and Repair to Concrete is included in Section 03922.

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. ASTM A82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.

2. ASTM A185 - Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.

3. ASTM A615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

4. ASTM A706 - Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.

B. American Concrete Institute (ACI):

1. ACI 301 - Specifications for Structural Concrete.

2. ACI 315 - Details and Detailing of Concrete Reinforcement.

3. ACI 318 - Building Code Requirements for Structural Concrete.

4. ACI SP-66 - ACI Detailing Manual.

C. Concrete Reinforcing Steel Institute (CRSI):

1. Manual of Standard Practice.

D. American Welding Society (AWS):

1. AWS D1.4 - Structural Welding Code Reinforcing Steel.

1.04 SUBMITTALS

A. Product Data: Submit product data showing materials of construction for:

1. Reinforcing steel.

2. Mechanical reinforcing steel splicers. Product data including ICC Evaluation Service Reports.

B. Shop Drawings: Submit to shop drawings showing details of installation for:

1. Reinforcing steel placing drawings. Placement drawings shall conform to the recommendations of ACI 315 and shall not be copies of the Contract Drawings. New scaled drawings shall be prepared showing plans, vertical structure elevations, sections, and details as required to clearly delineate the reinforcing. Reinforcement in a concrete placement shall be included on a single placement drawing or cross-referenced to the pertinent main placement drawing. The main drawing shall include bar lists, schedule, bending details, placing plans and elevations, clear concrete cover, splice locations, splice length, and the additional reinforcement (around openings, at corners, etc.) shown on the standard detail sheets. Bars to be of special steel or special yield strength are to be clearly identified.

2. Bill of material (bar list). Clearly show the placement of each bar listed in the bill of materials on the placement drawings.

3. Bar bending details. The bars shall be referenced to the same identification marks shown on the placement drawings. Include standard bending diagrams in the submittal, as applicable. Bars to be of special steel or special yield strength shall be clearly identified.

D. Samples

1. Provide samples of each type of mechanical reinforcing steel splicers.

E. Quality Assurance/Control: Submit test reports of each of the following items.

1. Certified copy of mill test on each steel proposed for use showing the physical properties of the steel and the chemical analysis.

2. Certified copy of test reports for each foreign manufactured steel proposed for use in the fabrication of reinforcement. The tests shall be specifically made for

this project at the expense of the CONTRACTOR by a domestic independent testing laboratory certified to perform the tests. The testing shall be for conformity to the applicable ASTM standard.

3. Welder's certification. The certification shall be in accordance with AWS D1.4 when welding of reinforcement required.

1.05 QUALITY ASSURANCE

A. CONTRACTOR shall ensure that metal pipeline embeds are separated from form ties and rebar by a minimum of 2-inch, in order to keep pipelines electrically isolated.

1.06 DELIVERY, STORAGE AND HANDLING

A. Reinforcing steel shall be substantially free from mill scale, rust, dirt, grease, or other foreign matter.

B. Reinforcing steel shall be shipped and stored with bars of the same size and shape fastened in bundles with durable tags, marked in a legible manner with waterproof markings showing the same "mark" designations as those shown on the submitted placement drawings.

C. Reinforcing steel shall be stored off the ground, protected from moisture and kept free from dirt, oil, or other injurious contaminants.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials shall be new and shall comply with the following material specifications.

B. Deformed Concrete Reinforcing Bars: ASTM A615, Grade 60 deformed bars.

C. Welded Steel Wire Fabric: ASTM A185.

D. Reinforcing Steel Accessories

1. Plastic Protected Bar Supports: CRSI Bar Supports, Class 1 - Maximum Protection.

2. Stainless Steel Protected Wire Bar Supports: CRSI Bar Supports, Class 2 - Moderate Protection with legs made wholly from stainless steel wire.

3. Precast Concrete Bar Supports: CRSI Bar Supports, Precast Concrete Bar Supports. Precast concrete blocks that have equal or greater strength than the surrounding concrete.

E. Tie Wire

1. Tie wires for reinforcement shall be 16-gauge or heavier, black annealed wire.

F. Mechanical Reinforcing Steel Coupling System

1. Use only where indicated. Mechanical reinforcing steel coupling system shall be positive connecting taper threaded type employing a hexagonal coupler. Coupling system shall meet ACI 318 requirements. Bar ends must be taper threaded with coupler manufacturer's bar threader to ensure proper taper and thread engagement. Provide with cap on female end to exclude dirt, debris and wet concrete. Couplers shall be torqued to manufacturer's recommended value.

2. Unless otherwise noted on the Drawings, mechanical reinforcing steel coupling system shall produce a splice strength in tension or compression of not less than 125 percent of the ASTM specified minimum yield strength of the reinforcing bar. Base yield strength on Grade 60 reinforcing unless otherwise indicated or specified.

3. Compression type mechanical splices shall provide concentric bearing from one bar to the other bar.

G. Headed Reinforcement

1. Headed reinforcement bars shall be mechanical devices complying with ACI 318 Section 12.6 for use as mechanical anchorage to develop steel reinforcement bars in tension as an alternate to standard hooks or development lengths. Development length shall be as required per manufacturer recommendations unless detailed otherwise in the Drawings. Headed reinforcement shall be HRC 555 Headed Reinforcing Bars by Headed Reinforcement Corporation, Fountain Valley, CA or equal.

2.02 FABRICATION

A. Fabrication of reinforcement shall be in compliance with the CRSI Manual of Standard Practice and ACI 315.

B. Bars shall be cold bent. Bars shall not be straightened or rebent.

C. Bars shall be bent around a revolving collar having a diameter of not less than that recommended by the ACI 318.

D. Bar ends that are to be butt spliced, placed through limited diameter holes in metal or threaded, shall have the applicable end(s) saw-cut. Such ends terminate in flat surfaces within 1-1/2 degrees of a right angle to the axis of the bar.

PART 3 EXECUTION

3.01 INSTALLATION

A. Surface condition, bending, spacing and tolerances of placement of reinforcement shall comply with the CRSI Manual of Standard Practice. The CONTRACTOR shall be solely

responsible for providing an adequate number of bars and maintaining the spacing and clearances shown on the Drawings.

B. Except as otherwise indicated on the Drawings, the minimum concrete cover of reinforcement shall be as follows:

1. Concrete cast against and permanently exposed to earth: 3-in

2. Concrete exposed to soil, water, and/or weather: 2-in (including bottom cover of slabs over water or sewage)

3. Concrete not exposed to soil, water, sewage, sludge and/or weather:

a. Slabs (top and bottom cover), walls and joists – 2-in

b. Beams and columns (principal reinforcement) - 2-in

C. Reinforcement which will be exposed for a considerable length of time after being placed shall be coated with a heavy coat of neat cement slurry.

D. No reinforcing steel bars shall be welded either during fabrication or erection unless specifically shown on the Drawings or specified herein, or unless prior written approval has been obtained from the OWNER. Bars that have been welded, including tack welds, without such approval shall be immediately removed from the work. When welding of reinforcement is approved or called for, it shall comply with AWS D1.4.

E. Reinforcing steel interfering with the location of other reinforcing steel, conduits or embedded items may be moved within the specified tolerances or one bar diameter, whichever is greater. Greater displacement of bars to avoid interference shall only be made with the approval of the OWNER. Do not cut reinforcement to install inserts, conduits, mechanical openings or other items without the prior approval of the OWNER.

F. Securely support and tie reinforcing steel to prevent movement during concrete placement. Secure dowels in place before placing concrete. Wire tie ends shall be bent away from the outer surface of concrete elements.

G. Reinforcing steel bars shall not be field bent except where shown on the Drawings or specifically authorized in writing by the OWNER. If authorized, bars shall be cold-bent around the standard diameter spool specified in the CRSI. Do not heat bars. Closely inspect the reinforcing steel for breaks. If the reinforcing steel is damaged, replace, Cadweld or otherwise repair as directed by the OWNER. Do not bend reinforcement after it is embedded in concrete.

H. Reinforcing steel bars shall have minimum clearance of 2-in from metal items such as rebar, wire, or plates used to support pipe penetrations and pipe embedments.

I. Reinforcing steel bars shall be cleaned before concrete placement. Reinforcing substantially (as determined by the OWNER) covered in rust shall be sandblasted clean prior to concrete placement.

3.02 REINFORCEMENT AROUND OPENINGS

A. Unless specific additional reinforcement around openings is shown on the Drawings, provide additional reinforcing steel on each side of the opening equivalent to one half of the cross-sectional area of the reinforcing steel interrupted by an opening. The bars shall have sufficient length to develop bond at each end beyond the opening or penetration.

3.03 SPLICING OF REINFORCEMENT

A. Lap splices shall be provided as shown on the Drawings. For lap splices not shown, request clarification from the OWNER.

B. Splicing of reinforcing steel in concrete elements noted to be "tension members" on the Drawings shall be avoided whenever possible. However, if required for constructability, splices in the reinforcement subject to direct tension shall be welded to develop, in tension, at least 125 percent of the specified yield strength of the bar. Splices in adjacent bars shall be offset the distance of a Class B splice.

C. Install wire fabric in as long a length as practicable. Wire fabric from rolls shall be rolled flat and firmly held in place. Splices in welded wire fabric shall be lapped in accordance with the requirements of ACI-318 but not less than 12-in. The spliced fabrics shall be tied together with wire ties spaced not more than 24-in on center and laced with wire of the same diameter as the welded wire fabric. Do not position laps midway between supporting beams, or directly over beams of continuous structures. Offset splices in adjacent widths to prevent continuous splices.

3.04 ACCESSORIES

A. The CONTRACTOR shall be solely responsible for determining, providing and installing accessories such as chairs, chair bars and the like in sufficient quantities and strength to adequately support the reinforcement and prevent its displacement during the erection of the reinforcement and the placement of concrete.

B. Use precast concrete blocks where the reinforcing steel is to be supported over soil.

C. Use plastic protected bar supports or steel supports with plastic tips where the reinforcing steel is to be supported on forms for a concrete surface that will be exposed to weather, high humidity, or liquid (including bottom of slabs over liquid containing areas). Use stainless steel supports or plastic tipped metal supports in all other locations unless otherwise noted on the Drawings or specified herein.

D. Alternate methods of supporting top steel in slabs, such as steel channels supported on the bottom steel or vertical reinforcing steel fastened to the bottom and top mats, may be used if approved by the OWNER

3.05 FIELD QUALITY CONTROL

A. Inspection: In no case shall any reinforcing steel be covered with concrete until the installation of the reinforcement, including the size, spacing and position of the reinforcement has been inspected by the OWNER. The OWNER shall be given a minimum of 2 working days prior notice of the readiness of placed reinforcement for

observation. The forms shall be kept open until the OWNER has finished their observations of the reinforcing steel.

B. CONTRACTOR shall ensure that metal pipeline embeds are separated from form ties and rebar by a minimum of 2-inch to keep pipelines electrically isolated.

END OF SECTION

SECTION 03250

CONCRETE JOINTS AND JOINT ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Concrete joints.

2. Concrete joint accessories.

1.02 RELATED WORK

A. Concrete Forms and Accessories is included in Section 03100.

B. Concrete Reinforcement is included in Section 03200.

C. Cast-In-Place Concrete is included in Section 03300.

D. Concrete Finishing is included in Section 03350.

E. Grout is included in Section 03600.

F. Modifications and Repair to Concrete is included in Section 03922.

G. Metal Fabrications is included in Section 05500.

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM)

1. ASTM A675 - Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties.

2. ASTM C881 - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.

3. ASTM C1059 - Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete.

4. ASTM D1751 - Standard Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction. (Nonextruding and Resilient Bituminous Types).

5. ASTM D1752 - Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.

B. U.S. Army Corps of Engineers (CRD).

1. CRD C572 - Specification for Polyvinylchloride Waterstops.

C. Federal Specifications

1. FS SS-S-210A - Sealing Compound for Expansion Joints.

D. International Concrete Repair Institute (ICRI):

1. ICRI Guideline No. 03732 – Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.

1.04 SUBMITTALS

A. Submit shop drawings and product data. Submittals shall include the following:

1. Standard Waterstops: Product data including catalogue cut, technical data, storage requirements, splicing methods and conformity to ASTM standards.

2. Waterstops placement drawing: Placement drawings shall also include locations and types of shop-fabricated intersections.

3. Bond breaker: Product data including catalogue cut, technical data, storage requirements, installation requirements, location of use and conformity to ASTM standards.

4. Compressible joint filler: Product data including catalogue cut, technical data, storage requirements, installation requirements, location of use and conformity to ASTM standards.

5. Bonding agents: Product data including catalogue cut, technical data, storage requirements, product life, application requirements and conformity to ASTM standards.

B. Certifications

1. Certification that materials used within the joint system are compatible with each other.

PART 2 PRODUCTS

2.01 GENERAL

A. Materials used together in a given joint (bond breakers, backer rods, joint fillers, sealants, etc.) shall be compatible with one another. Coordinate selection of suppliers and products to ensure compatibility. Under no circumstances shall asphaltic or bituminous bond breakers or joint fillers be used in joints receiving sealant.

B. Chemical sealant type waterstops shall be products specifically manufactured for the purpose for which they will be used and the products shall have been successfully used on similar structures for more than five years.

2.02 MATERIALS

A. Standard Waterstops

1. PVC Waterstops – The PVC waterstops shall be made by extruding elastomeric plastic compound with virgin polyvinylchloride as the basic resins. The compound shall contain no reprocessed materials. Minimum tensile strength of waterstop shall be 1750 psi. The waterstop shall conform to CRD-C572. Waterstops for joints shall be a 6-in wide and be the flat ribbed type. Waterstops shall be style 679 by Greenstreak Plastic Products, St. Louis, MO; style R6-38 by Vinylex Corp., Knoxville, TN, or equal. Equal waterstops may have an integral fastening system. Provide shop-fabricated waterstop fittings for intersections. Only straight butt joint splices may be made in the field.

B. Bond Breaker

1. Bond breaker tape shall be an adhesive-backed glazed butyl or polyethylene tape which will satisfactorily adhere to the premolded joint filler or concrete surface as required. The tape shall be the same width as the joint unless otherwise noted.

2. Except where tape is specifically called for on the drawings, bond breaker for concrete shall be either bond breaker tape or a non-staining type bond prevention coating such as Williams Tilt-up Compound by Williams Distributors Inc.; Silcoseal 2000C, by SCA Construction Supply Division, Superior Concrete Accessories or equal.

3. Apply bondbreaker such that it does not remain on rebar or waterstops when pouring concrete.

C. Bonding Agent

1. Epoxy bonding agent shall be a two-component, solvent-free, moisture insensitive, epoxy resin material conforming to ASTM C881 (2002), Type V. The bonding agent shall be Sikadur 32 Hi-Mod by Sika Corporation of Lyndhurst, N.J.; Concresive Liquid (LPL) by BASF of Florham Park, NJ or equal.

2. Latex bonding agent shall be a non-reemulsifiable acrylic-polymer latex conforming to ASTM C1059, Type II.

D. Joint Sealant

1. Joint sealants shall be two-part urethane sealant. Minimum sealant thickness at concrete joints shall be 3/8-in. Joint sealant shall be Sikaflex 2C by Sika Corporation, Lyndhurst, NJ; or equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. PVC Waterstops

1. Install PVC waterstops for joints where waterstops are indicated on the Drawings, unless specifically noted otherwise. Waterstops shall be continuous around corners and intersections so that a continuous seal in provided.

2. PVC splices shall be made by welding in accordance with the manufacturer's recommendations, subject to acceptance of the OWNER. Waterstop intersection fittings shall be shop fabricated. Only straight butt joint splices may be made in the field. Only manufacturer's approved tools shall be used for welding. The finish splices shall provide a cross-section that is dense and free of porosity.

3. Each piece of the waterstop shall be of maximum practicable length to provide a minimum number of splices.

4. To properly secure PVC waterstops in wall joints before concrete is placed, drill holes in waterstops approximately 1-in from each edge or between the outermost ribs at each edge and center the waterstop in the joint. Tie both edges of the waterstop and fasten to reinforcing steel with black annealed steel tie wire as specified for tying reinforcing steel and secure in place so that the waterstop will be perpendicular to the joint and remain in the required position during concrete placement. The spacing of the waterstop ties shall match the spacing of the adjacent reinforcement, but need not be spaced closer than 12-in on center.

5. Horizontal waterstops in slabs shall be clamped in position by the bulkhead (unless previously set in concrete).

B. Construction Joints

1. Make construction joints only at locations shown on the Drawings or as approved by the OWNER. Any additional or relocation of construction joints proposed by the CONTRACTOR, must be submitted to the OWNER for written approval.

2. Additional or relocated joints should be located where they least impair strength of the member. In general, locate joints within the middle third of spans of slabs, beams and girders. However, if a beam intersects a girder at the joint, offset the joint a distance equal to twice the width of the member being connected. Locate joints in walls and columns at the underside of floors, slabs, beams or girders and at tops of footings or floor slabs. Do not locate joints between beams, girders, column capitals, or drop panels and the slabs above them. Do not locate joints between brackets or haunches and walls or columns supporting them.

3. Joints shall be perpendicular to main reinforcement. Continue reinforcing steel through the joint as indicated on the Drawings. When joints in beams are allowed, provide a shear key and inclined dowels as approved by the OWNER.

4. Provide sealant grooves for joint sealant where indicated on the Drawings.

5. At construction joints and at concrete joints designated on the Drawings to be "roughened", uniformly roughen the surface of the concrete to Concrete Surface Profile (CSP) 9 per ICRI Guideline 03732 with ¼-in minimum amplitude. This roughened surface may be accomplished by raking the plastic concrete or by bushhammering or chiseling hardened concrete surfaces or raking plastic concrete. Thoroughly clean joint surfaces of loose or weakened materials by waterblasting or sandblasting. Saturate the joints and adjacent concrete surfaces to at least 12-in past the joint with water 12 hours before and again immediately prior to concrete placement.

6. Galvanized metal stay-in-place forms shall not be used in the construction joints of any liquid-containing structures.

7. In lieu of the above method for bonding plastic concrete to hardened concrete, the following optional method may be used. Concrete must be allowed to set a minimum of 28 days. Use an epoxy bonding agent applied to roughened and cleaned surfaces of set concrete in strict accordance with manufacturer's recommendations.

8. Provide waterstops in wall and slab construction joints in liquid containment structures and at other locations shown on the Drawings.

9. Keyways shall not be used in construction joints unless specifically shown on the Drawings or approved by the OWNER.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Cast-in-place concrete.

B. Furnish, as required to establish concrete mixes, sampling and laboratory testing of products and materials performed by an independent testing laboratory engaged by and at the expense of the CONTRACTOR.

1.02 RELATED WORK

A. Concrete Forms and Accessories is included in Section 03100.

B. Concrete Reinforcement is included in Section 03200.

C. Concrete Joints and Accessories is included in Section 03250.

D. Concrete Finishing is included in Section 03350.

E. Grout is included in Section 03600.

F. Modifications and Repair to Concrete is included in Section 03922.

1.03 SUBMITTALS

A. Submit to the OWNER product data for:

1. Sources of cement, pozzolan, aggregates, and batched concrete.

2. Air-entraining admixture. Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations and conformity to ASTM standards.

3. Water reducing admixture. Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations and conformity to ASTM standards.

4. Sheet curing material. Product data including catalogue cut, technical data and conformity to ASTM standard.

5. Liquid curing compound. Product data including catalogue cut, technical data, storage requirements, product life application rate and conformity to ASTM C309 standard. Identify proposed locations of use.

6. Material Safety Data Sheets (MSDS) for concrete components and admixtures.

B. Samples

1. Fine and coarse aggregates if requested for examination by the OWNER.

C. Test Reports

1. Aggregates: Conformance to ASTM standards, including sieve analysis, physical properties, and deleterious substance content.

2. Cement: Conformance to ASTM standards, including chemical analysis and physical tests.

3. Concrete mixes: For each formulation of concrete proposed for use, submit constituent quantities per cubic yard, water cementitious ratio, air content, concrete slump, type and manufacturer of cement. Provide either Paragraph a. or b., below, for each mix proposed.

a. Compression test results for proposed mixes. Include standard deviation data for each proposed concrete mix based on statistical records.

b. The curve of water-cementitious materials ratio versus concrete cylinder strength for each formulation of concrete proposed based on laboratory tests. The cylinder strength shall be the average of the 28 day cylinder strength test results for each mix. Provide results of 7 and 14 day tests if available.

D. Certifications

1. Certify that admixtures used in the same concrete mix are compatible with each other and the aggregates.

2. Certify that the CONTRACTOR is not associated with the independent testing laboratory proposed for use by the CONTRACTOR nor does the CONTRACTOR or officers of the CONTRACTOR's organization have a beneficial interest in the laboratory.

3. Certificate of conformance for concrete production facilities from the NRMCA.

E. Work Plans

1. Hot weather concreting.

2. Cold weather concreting.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.

2. ASTM C33 - Standard Specification for Concrete Aggregates.

3. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

4. ASTM C42 – Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.

5. ASTM C94 - Standard Specification for Ready-Mixed Concrete.

6. ASTM C138 – Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.

7. ASTM C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete

8. ASTM C150 - Standard Specification for Portland Cement

9. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete

10. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.

11. ASTM C192 – Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.

12. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.

13. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.

14. ASTM C309 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

15. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.

16. ASTM C596 – Standard Test Method for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.

17. ASTM C1077 - Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.

18. ASTM C1260 - Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).

19. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection and/or Testing.

B. American Concrete Institute (ACI).

1. ACI 304R - Guide for Measuring, Mixing, Transporting and Placing Concrete.

2. ACI 305R - Hot Weather Concreting.

3. ACI 306.1 – Standard Specification for Cold Weather Concreting

4. ACI 318 - Building Code Requirements for Structural Concrete and Commentary.

C. National Ready Mixed Concrete Association (NRMCA)

1. Quality Control Manual, Section 3 - Certification of Ready Mixed Concrete Production Facilities.

D. Truck Mixer Manufacturers Bureau (TMMB)

1. TMMB 100 - Truck Mixer, Agitator and Front Discharge Concrete Carrier Standards.

1.05 QUALITY ASSURANCE

A. Reinforced concrete shall comply with ACI 318 and other stated specifications, codes and standards. Apply the most stringent requirements of other stated specifications, codes, standards, and this Section when conflicts exist.

B. Only one source of cement and aggregates shall be used for the project. Concrete shall be uniform in color and appearance.

C. If, during the progress of the work, it is impossible to secure concrete of the specified workability and strength with the materials being furnished, the OWNER may order such changes in proportions or materials, or both, as may be necessary to secure the specified properties. All changes so ordered shall be made at no additional cost to the OWNER.

D. If, during the progress of the work, the materials from the sources originally accepted change in characteristics, the OWNER may make new acceptance tests of materials and establish new concrete mixes with the assistance of an independent testing laboratory. All changes so ordered shall be made at no additional cost to the OWNER.

E. Testing of the following materials shall be furnished by Contractor to verify conformity with this Specification Section and the stated ASTM standards.

1. Fine aggregates for conformity with ASTM C33 – sieve analysis, physical properties, and deleterious substances.

2. Coarse aggregates for conformity with ASTM C33 – sieve analysis, physical properties, and deleterious substances

3. Cements for conformity with ASTM C150 –chemical analysis and physical properties.

4. Pozzolans for conformity with ASTM C618 – chemical analysis and physical properties.

5. Proposed concrete mix designs – compressive strength, slump, shrinkage, and air content.

F. Field testing and inspection services and related laboratory tests will be provided by the OWNER. Methods of testing shall comply with the latest applicable ASTM methods. The following items shall be tested to verify conformity with this Section.

1. Concrete placements - compressive strength (cylinders), compressive strength (cores), temperature, slump, and air content.

2. Other materials that may require field testing.

G. Provide laboratory tests of samples of constituents and of concrete as-placed. Materials incorporated in the work shall conform to accepted samples and test reports.

1.06 DELIVERY, STORAGE AND HANDLING

A. Cement: Store in weathertight buildings, bins or silos to provide protection from dampness and contamination and to prevent warehouse set.

B. Aggregate: Arrange and use stockpiles to prevent segregation or contamination with other materials or with other sizes of like aggregates. Build stockpiles in successive horizontal layers not exceeding three feet in thickness. Complete each layer before the next is started. Do not use frozen or partially frozen aggregate.

C. Sand: Arrange and use stockpiles to prevent contamination. Allow sand to drain to a uniform moisture content before using. Do not use frozen or partially frozen sand.

D. Admixtures: Store in closed containers to prevent contamination, evaporation or damage. Provide agitating equipment to uniformly disperse ingredients in admixture solutions which tend to separate. Protect liquid admixtures from freezing and other temperature changes which could adversely affect their characteristics.

E. Pozzolan: Store in weathertight buildings, bins or silos to provide protection from dampness and contamination.

F. Sheet Curing Materials: Store in weathertight buildings or off the ground and under cover.

G. Liquid Curing Compounds: Store in closed containers.

PART 2 PRODUCTS

2.01 GENERAL

A. Like items of materials shall be the end products of one manufacturer in order to provide standardization for appearance, maintenance and manufacturer's service.

2.02 MATERIALS

A. Materials shall comply with this Section and any applicable State or local requirements.

B. Cement: Domestic portland cement conforming to ASTM C150. Do not use air entraining cements. Cement brand must be approved by the OWNER and one brand shall be used throughout the work. Provide the following type(s) of cement:

1. Class 150 Concrete - Type II

C. Aggregates:

1. Fine Aggregate: Washed inert natural sand conforming to the requirements of ASTM C33.

2. Coarse Aggregate: Well-graded crushed stone or washed gravel conforming to the requirements of ASTM C33. Grading requirements as listed in ASTM C33, Table 2 for the specified coarse aggregate size number listed in Table 1 herein. Limits of deleterious substances and physical property requirements as listed in ASTM C33, Table 3 for severe weathering regions. Do not use coarse aggregates known to be deleteriously reactive with alkalis in cement.

3. The fine and coarse aggregates used shall not cause expansion of mortar bars greater than 0.1 percent in 16 days when tested in accordance with ASTM C1260 and using the cement proposed for the project. If aggregates proposed for use do not meet this requirement, then satisfy a. below.

   a. Total equivalent alkali content of the cement used shall not exceed 0.60 percent as provided in the Optional Chemical Requirements of ASTM C150.

D. Water: Potable water free of oil, acid, alkali, salts, chlorides (except those attributable to drinking water), organic matter, or other deleterious substances.

E. Admixtures: Admixtures shall be free of chlorides and alkalis (except for those attributable to drinking water). The admixtures shall be from the same manufacturer when it is required to use more than one admixture in the same concrete mix. Use admixtures compatible with the concrete mix including other admixtures.

1. Air Entraining Admixture: Conforming to ASTM C260. Proportion and mix in accordance with manufacturer's recommendations.

2. Water Reducing Admixture: The admixture shall comply with ASTM C494, Type A. Proportion and mix in accordance with manufacturer's recommendations.

3. Admixtures causing retarded or accelerated setting of concrete shall not be used without written approval from the OWNER. Use retarding or accelerating water reducing admixtures when so approved.

F. Pozzolan (Fly Ash). Pozzolan shall be Class C or Class F fly ash complying with ASTM C618 except the Loss of Ignition (LOI) shall be limited to 3 percent maximum.

G. Sheet Curing Materials. Waterproof paper, polyethylene film or white burlap-polyethylene sheeting, complying with ASTM C171.

H. Liquid Curing Compound. Liquid membrane-forming curing compound shall comply with the requirements of ASTM C309, Type 1-D (clear or translucent with fugitive dye) and shall contain no wax, paraffin, or oil.

2.03 MIXES

A. An independent testing laboratory engaged by and at the expense of the OWNER shall establish concrete mixes and perform sampling and laboratory testing of products and materials.

B. Select proportions of ingredients to meet the design strength and materials limits specified in Table 03300-1 and to produce placeable, durable concrete conforming to these specifications. Proportion ingredients to produce a homogenous mixture which will readily work into corners and angles of forms and around reinforcement without permitting materials to segregate or allowing free water to collect on the surface.

C. Base concrete mixes on standard deviation data of prior mixes with essentially the same proportions of the same constituents or, if not available, develop concrete mixes by laboratory tests using the materials proposed for the work.

1. For concrete mixes based on standard deviation data of prior mixes, submit standard deviation data of prior mixes with essentially the same proportions of the same constituents in accordance with ACI 318 and based on the modification factors for standard deviation tests contained in ACI 318.

2. For concrete mixes developed by laboratory testing, base cementitious content of the concrete on curves showing the relation between water cementitious ratio and 7, 14 and 28 day compressive strengths of concrete made using the proposed materials. The curves shall be determined by four or more points, each representing an average value of at least three test specimens and one water-cementitious ratio at each age. Provide curves with a range of values sufficient to yield the desired data, including the specified design strengths, without extrapolation. The water content of the concrete mixes to be used, as determined from the curve, shall correspond to strengths 16 percent greater than the specified design strengths. The resulting mix shall not conflict with the limiting values for maximum water cementitious ratio and net minimum cementitious content specified in Table 03300-1. Acceptance of mixes based on standard deviation shall be based on the modification factors for standard deviation tests contained in ACI 318.

D. Test aggregates for potential alkali reactivity in accordance with ASTM C1260. If initial testing indicates aggregates are not potentially reactive repeat test at 3 month intervals.

E. Compression Tests: Provide testing of the proposed concrete mixes to demonstrate compliance with the compression strength requirements in conformity with the provisions of ACI 318.

F. Entrained air, as measured by ASTM C231, shall be as shown in Table 03300-1.If the air entraining agent proposed for use in the mix requires testing methods other than ASTM C231 to accurately determine air content, make special note of this requirement in the admixture submittal specified under Paragraph 1.03.

G. Slump of the concrete as measured by ASTM C143, shall be as shown in Table 03300-1.

H. Proportion admixtures according to the manufacturer's recommendations. Two or more admixtures specified may be used in the same mix provided that the admixtures in combination retain full efficiency and have no deleterious effect on the concrete or on the properties of the other admixture(s).

TABLE 03300-1

CONCRETE MIX REQUIREMENTS

Class	Design Strength (1)	Cement (2)	Fine Aggregate (3)	Coarse Aggregate (3)	Cementitious Content (4)
A	2500	C150 Type II	Sand	57	440
B	3000	Type II	Sand	57	480
D	4000	C150 Type II	Sand	57	560

Class	W/C Ratio (5)	Fly Ash (6)	AE Range (7)	WR (8)	HRWR (9)	Slump Range Inches
A	0.62 max.	Yes	3.5 to 5	Yes	No	1-4
B	0.54 max.	Yes	3.5 to 5	Yes	No	1-3D
0.45 max.	Yes	3.5 to 5	Yes	No	3-5	

NOTES:

1. Minimum compressive strength in psi at 28 days
2. ASTM designation in ASTM C150
3. Size Number in ASTM C33
4. Minimum cementitious content in lbs per cubic yard (where fly ash is used cementitious content is defined as cement content plus fly ash content)
5. W/C is Maximum Water Cementitious ratio by weight
6. Fly ash content in the range of 20-25 percent of the total cement content plus fly ash content, by weight
7. AE is percent air entrainment
8. WR is water reducing admixture
9. HRWR is high-range water-reducing admixture

PART 3 EXECUTION

3.01 MEASURING MATERIALS

A. Concrete shall be composed of portland cement, fine aggregate, coarse aggregate, water and admixtures as specified and produced by a plant complying with ACI 318 and ASTM C94, and acceptable to the OWNER. Constituents, including admixtures, shall be batched at the plant.

B. Measure materials for batching concrete by weighing in conformity with and within the tolerances given in ASTM C94 and ACI 304R except as otherwise specified. Scales shall have been certified by the local Sealer of Weights and Measures within one year of use.

C. Measure the amount of free water in fine aggregates within 0.3 percent with a moisture meter. Compensate for varying moisture contents of fine aggregates. Record the number of gallons of water as-batched on printed batching tickets.

D. Admixtures shall be dispensed either manually using calibrated containers or measuring tanks, or by means of an automatic dispenser approved by the manufacturer of the specific admixture.

1. Charge air-entraining and chemical admixtures into the mixer as a solution using an automatic dispenser or similar metering device.

2. Inject multiple admixtures separately during the batching sequence.

3.02 MIXING AND TRANSPORTING

A. Concrete shall be ready-mixed concrete produced by equipment complying with ACI 318 and ASTM C94 and produced by a plant certified by the NRMCA. Hand-mixing will not be permitted. Truck mixers shall carry a rating plate conforming to TMMB 100. Clean each transit mix truck drum and reverse drum rotation before the truck proceeds under the batching plant. Equip each transit-mix truck with a continuous, nonreversible, revolution counter showing the number of revolutions at mixing speeds.

B. Ready-mix concrete shall be transported to the site in watertight agitator or mixer trucks loaded not in excess of their rated capacities as stated on the name plate.

C. Keep the water tank valve on each transit truck locked. Any addition of water must be directed by the OWNER. Added water shall be incorporated by additional mixing of at least 35 revolutions at mixing speed after the addition of water. Added water shall be metered and the amount of water added shall be shown on each delivery ticket.

D. All Central plant and rolling stock equipment and methods shall comply with ACI 318, ACI 304R and ASTM C94.

E. Select equipment of size and design to provide continuous flow of concrete at the delivery end. Use metal or metal-lined non-aluminum discharge chutes with slopes not exceeding one vertical to two horizontal and not less than one vertical to three horizontal. Chutes more than 20-ft long and chutes not meeting slope requirements may be used if concrete is discharged into a hopper before distribution.

F. Retempering (mixing with or without additional cement, aggregate, or water) concrete or mortar which has partially hardened will not be permitted.

G. Handle concrete from mixer to placement as quickly as practicable while providing concrete of specified quality in the placement area. Dispatch trucks from the batching plant so they arrive at the work site just before the concrete is required to avoid excessive mixing of.

H. Furnish a delivery ticket for ready mixed concrete to the OWNER as each truck arrives. Each ticket shall provide a printed record of the weight of cement and each aggregate as batched individually. Use the type of indicator that returns for zero punch or returns to zero after a batch is discharged. Clearly indicate the weight of fine and coarse aggregate, cement, fly ash, and water in each batch, brand and quantity of each admixture, the quantity of concrete delivered, the time any water is added and the amount, and the numerical sequence of the delivery. Show the time of day batched and time of discharge from the truck. Indicate the number of revolutions of the truck mixer. Annotate each delivery ticket with the structure and component where the concrete was placed.

I. Temperature and Mixing Time Control

1. In cold weather maintain the as-mixed temperature of the concrete and concrete temperatures at the time of placement in the forms as indicated in Table 03300-3.

2. If water or aggregate has been heated, combine water with aggregate in the mixer before cement is added. Do not add cement to mixtures of water and aggregate when the temperature of the mixture is greater than 90 degrees F.

3. In hot weather cool ingredients before mixing to maintain temperature of the concrete below the maximum placing temperature of 90 degrees F. Well-crushed ice may be substituted for all or part of the mixing water.

4. The maximum time interval between the addition of mixing water and/or cement to the batch and the final placing of concrete in the forms shall not exceed the values shown in Table 03300-2:

TABLE 03330-2

MAXIMUM TIME TO DISCHARGE OF CONCRETE

AIR OR CONCRETE TEMPERATURE (WHICHEVER IS HIGHER)	MAXIMUM TIME
Above 90 Degree F (32 Degree C) (Note 1)	60 minutes
(27 Degree C) 80 Degree F to 90 Degree F (32 Degree C)	60 minutes
(21 Degree C) 70 Degree F to 79 Degree F (26 Degree C)	75 minutes
(5 Degree C) 40 Degree F to 69 Degree F (20 Degree C)	90 minutes

Note 1: In air temperatures above 90 degree F, the temperature of concrete being placed shall not exceed 90 degrees F.

3.03 INSPECTION AND COORDINATION

A. Batching, mixing, transporting, placing and curing of concrete shall be subject to the inspection of the OWNER at any time. Advise the OWNER of readiness to proceed at least six working hours prior to each concrete placement. The OWNER will inspect the preparations for concreting including the preparation of previously placed concrete, the reinforcing and the alignment, cleanliness and tightness of formwork. Do not place concrete without the inspection and acceptance of the OWNER.

3.04 EMBEDDED ITEMS

A. Secure to forms as required or set for embedment as required, miscellaneous metal items, sleeves and other items furnished under other Sections and required to be embedded into concrete. Set and secure such items in the locations and alignments needed so they are not displaced by concrete placement.

B. Clean embedded items free of rust, mud, dirt, grease, oil, ice, or other contaminants which would reduce or prevent bonding with concrete.

C. Coat or isolate aluminum embedments to prevent aluminum-concrete reaction or electrolytic action between aluminum and steel.

D. Do not embed piping in concrete unless shown on the Drawings.

E. Close open ends of piping, conduits, and sleeves embedded in concrete with caps or plugs prior to placing concrete.

F. Ensure specified tests and inspections on embedded piping are completed and satisfactory before starting concrete placement. Ensure mechanical or electrical tests and inspections are completed and satisfactory prior to starting concrete placement. Do not place concrete until unsatisfactory items and conditions have been corrected.

G. Check location, alignment, and support of piping and other items which will be fully or partially embedded in concrete before depositing concrete. Correct mislocated and misaligned items and secure items which have become loose before depositing concrete.

H. Correct embedded items not installed in the location or alignment needed or displaced by concrete placement at no additional cost to the OWNER.

3.05 CONCRETE APPEARANCE

A. Concrete mix showing either poor cohesion or poor coating of the coarse aggregate with paste shall be remixed. Remixed concrete showing either poor cohesion or poor coating of the coarse aggregate with paste shall be rejected. If the slump is within the allowable limit, but excessive bleeding, poor workability, or poor finishability are observed, changes in the concrete mix shall be obtained only be adjusting one or more of the following:

1. The gradation of aggregate.

2. The proportion of fine and coarse aggregate.

3. The percentage of entrained air, within the allowable limits.

B. Concrete for the work shall provide a homogeneous structure which, when hardened, will have the specified strength, durability and appearance. Mixtures and workmanship shall be such that concrete surfaces, when exposed, will require no finishing. When concrete surfaces are strippled, the concrete, when viewed in good lighting from 10-ft away, shall be pleasing in appearance, and at 20-ft shall show no visible defects.

3.06 PLACING AND COMPACTING

A. Placing

1. Verify that formwork completely encloses concrete to be placed and is securely braced prior to concrete placement. Remove ice, standing water, dirt, debris, and other foreign materials from forms and exposed joint surfaces. Confirm that reinforcement and other embedded items are securely in place. Have a worker at the location of the placement that can check that reinforcement and embedded items remain in designated locations and alignments while concrete is being placed. Sprinkle semi-porous subgrades or forms to eliminate suction of water from the mix.

2. Deposit concrete as near its final position as possible to prevent segregation due to rehandling or flowing. Place concrete continuously at a rate that allows the concrete previously placed to be integrated with fresh plastic concrete. Do not deposit concrete which has partially hardened or has been contaminated by foreign materials or on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within the section. If the section cannot be placed continuously, place construction joints as specified or as approved.

3. Pumping of concrete will be permitted. Use a mix design and aggregate sizes chosen for pumping and submit for approval. Do not use pipelines made of aluminum or aluminum alloy. When concrete is pumped, slump will be determined at point of truck discharge and air content will be determined at point of placement.

4. Remove temporary spreaders from forms when the spreader is no longer needed. Temporary spreaders may remain embedded in concrete only when made of galvanized steel or concrete and if prior approval from the OWNER has been obtained.

5. Do not place concrete for supported elements until concrete previously placed in the supporting element has attained adequate strength.

6. Where surface mortar is to form the base of a finish, especially surfaces designated to be painted, work coarse aggregate back from forms to bring the full surface of the mortar against the form. Prevent the formation of surface voids.

7. Slabs

    a. After bulkheads, screeds and jointing materials have been positioned, place concrete continuously between joints beginning at a bulkhead, edgeform, or corner. Place each batch into the edge of the previously placed concrete to avoid stone pockets and segregation.

    b. Avoid delays in placement. If there is a delay in placement, spade and consolidate the concrete placed after the delay at the edge of the previously placed concrete to avoid cold joints. Concrete shall then be brought to correct level and struck off with a straightedge. Bullfloats or darbies shall be used to smooth the surface, leaving it free of humps or hollows. Use aluminum magnesium floats for air entrained concrete.

    c. Where slabs are to be placed integrally with the walls below them, place the walls and compact as specified. Allow 1 hour to pass between placement of the wall and the overlying slab to permit consolidation of the wall concrete. Keep the top surface of the wall moist so as to prevent cold joints.

8. Formed Concrete

    a. Place concrete in forms using tremie tubes taking care to prevent segregation. Bottom of tremie tubes shall preferably be in contact with the concrete already placed. Do not permit concrete to drop freely more than 4-ft. Place concrete for walls in 12 to 24-in lifts, keeping the surface horizontal.

B. Compacting

1. Consolidate concrete by vibration and puddling, spading, rodding or forking so that concrete is completely worked around reinforcement, embedded items and openings and into corners of forms. Puddling, spading, etc shall continuously be performed along with vibration of the placement to eliminate air or stone pockets which may cause honeycombing, pitting or planes of weakness.

2. Concrete shall be compacted with mechanical vibrators One vibrator shall be used for each 8 c.y. placed per hour. The type and size of the units shall be approved by the OWNER in advance of placing operations. No concrete shall be ordered until sufficient approved vibrators (including standby units in working order) are on the job.

3. A minimum frequency of 7000 rpm is required for mechanical vibrators. Insert vibrators and withdraw at points from 18-in to 30-in apart. At each insertion, vibrate sufficiently to consolidate concrete, generally from 5 to 15 seconds. Do not segregate concrete through overvibration. Keep standby vibrators on the site during concrete placing operations.

4. Concrete Slabs: Concrete for slabs less than 8-in thick shall be consolidated by vibrating screeds; Slabs 8-in and thicker shall be compacted by internal vibrators and (optionally) with vibrating screeds. Place vibrators into concrete vertically. Do not lay vibrators horizontally or lay over.

5. Walls: Internal vibrations (rather than form vibrators) shall be used unless otherwise approved by the OWNER. In general, for each vibrator needed to melt down the batch at the point of discharge, one or more additional vibrators must be used to densify, homogenize and perfect the surface. The vibrators shall be inserted vertically at regular intervals, through the fresh concrete and slightly into the previous lift, if any.

6. Amount of Vibration: Vibrators are to be used to consolidate properly placed concrete but shall not be used to move or transport concrete in the forms. Vibration shall continue until:

   a. Frequency of vibrator returns to normal.

   b. Surface appears liquefied, flattened and glistening.

   c. Trapped air ceases to rise.

   d. Coarse aggregate has blended into surface, but has not disappeared.

3.07 CURING AND PROTECTION

A. Protect concrete work against injury from the elements and defacements of any nature during construction operations.

B. Curing Methods

1. Curing Methods for Concrete Surfaces: Cure concrete to retain moisture and maintain specified temperature at the concrete surface for a minimum of seven days after placement. Curing methods to be used are as follows:

a. Water Curing: Keep entire concrete surface wet by ponding, continuous sprinkling or covered with saturated burlap. Begin water curing as soon as concrete attains an initial set and maintain water curing 24 hours a day. Do not permit the surface of the concrete to dry out at any time during the curing period. Temperature of curing water shall be within 20 Degrees F of the concrete temperature.

b. Sheet Material Curing: Cover entire surface with sheet material. Securely anchor sheeting to prevent wind and air from lifting the sheeting or entrapping air under the sheet. Place and secure sheet as soon as initial concrete set occurs.

c. Liquid Membrane Curing: Apply over the entire concrete surface except for surfaces to receive additional concrete. Curing compound shall NOT be placed on any concrete surface where additional concrete is to be placed. Curing compound shall be applied as soon as the free water on the surface has disappeared and no water sheen is visible, but not after the concrete is dry or when the curing compound can be absorbed into the concrete. Application shall be in compliance with the manufacturer's recommendations.

2. Specified applications of curing methods:

a. Slabs for Liquid Retaining Structures: Water curing only.

b. Slabs on Grade and Footings (not used to retain liquids): Water curing or sheet material curing or liquid membrane curing.

c. Concrete Joints: Water curing or sheet material curing.

d. Horizontal Surfaces which will Receive Additional Concrete, Coatings, Grout, or Other Material that Requires Bond to the substrate: Water curing.

e. Formed Surfaces: None if nonabsorbent forms are left in place 7 days. Water cure, sheet cured or liquid membrane cured if forms are removed prior to 7 days. Exposed horizontal surfaces of formed walls or columns shall be water cured for 7 days or until next placement of concrete is made.

C. Finished surfaces and slabs shall be protected from the direct rays of the sun to prevent checking and crazing.

D. Cold Weather Concreting

1. "Cold weather" is defined as a period when for more than three successive days, the average daily outdoor temperature drops below 40 degrees F. The average daily temperature shall be calculated as the average of the highest and the lowest temperature during the period from midnight to midnight.

2. Batch, deliver, place, cure and protect concrete during cold weather in compliance with the recommendations of ACI 306R and the additional requirements of this Section.

3. The CONTRACTOR shall discuss a cold weather concreting plan with the OWNER at the preconstruction meeting. The discussion shall encompass the methods and procedures proposed for use during cold weather including the production, transportation, placement,

protection, curing and temperature monitoring of the concrete. The procedures to be implemented upon abrupt changes in weather conditions or equipment failures shall also be discussed. Cold weather concreting shall not begin until the work plan is acceptable to the OWNER.

4. The minimum temperature of concrete immediately after placement and during the protection period shall be as indicated in Table 03300-3. The temperature of the concrete in place and during the protection period shall not exceed these values by more than 20 degrees F. Prevent overheating and non-uniform heating of the concrete.

TABLE 03300-3

Concrete Temperatures
Minimum Dimension of Section

	< 12-in	12 to 36-in
Min. conc temp:	55 Degree F	50 Degree F

5. During periods of cold weather, concrete shall be protected to provide continuous warm, moist curing (with supplementary heat when required) for a total of at least 350 degree-days of curing.

   a. Degree-days are defined as the total number of 24 hour periods multiplied by the weighted average daily air temperature at the surface of the concrete (e.g., 7 days at an average 50 degrees F = 350 degree-days).

   b. To calculate the weighted average daily air temperature, sum hourly measurements of the air temperature in the shade at the surface of the concrete taking any measurement less than 50 degrees F as 0 degrees F. Divide the sum thus calculated by 24 to obtain the weighted average temperature for that day.

6. Salt, manure or other chemicals shall not be used for protection.

7. The protection period for concrete being water cured shall not be terminated during cold weather until at least 24 hours after water curing has been terminated.

8. During periods not defined as cold weather, but when freezing temperatures are expected or occur, protect concrete surfaces from freezing for the first 24 hours after placing.

E. Hot Weather Concreting

1. "Hot weather" is defined as any combination of high air temperatures, low relative humidity and wind velocity which produces a rate of evaporation as estimated in ACI 305R, approaching or exceeding 0.2 pounds per square foot per hour (lb/sq ft/hr).

2. Concrete placed during hot weather shall be batched, delivered, placed, cured and protected in compliance with the recommendations of ACI 305R and the additional requirements specified herein.

a. Temperature of concrete being placed shall not exceed 90 degrees F and every effort shall be made to maintain a uniform concrete mix temperature below this level. The temperature of the concrete shall not cause loss of slump, flash set or cold joints.

b. All necessary precautions shall be taken to promptly deliver concrete to the job and promptly place the concrete upon its arrival at the job and to provide vibration immediately after placement.

c. The OWNER may direct the CONTRACTOR to immediately cover concrete with sheet curing material.

3. The CONTRACTOR shall discuss with the OWNER an work plan describing the methods and procedures proposed to use for concrete placement and curing during hot weather periods. Hot weather concreting shall not begin until the work plan is acceptable to the OWNER.

3.08 REMOVAL OF FORMS

A. Form and shoring removal shall conform to the requirements specified in Section 03100.

3.09 FIELD AND LABORATORY TESTS

A. The placing and curing of concrete shall be subject to the inspection of the Special Inspector. The CONTRACTOR shall advise the Special Inspector of his/her readiness to proceed at least 2 working days prior to each concrete placement. The Special Inspector will inspect the preparations for concreting including the preparation of previously placed concrete, the reinforcing steel and the alignment, cleanliness, and tightness of formwork. No placement shall be made without the inspection and acceptance of the Special Inspection

B. Sets of concrete test cylinders taken of each class of concrete placed each day shall not be less than one set per day, nor less than one set for each 100 cu yds of concrete nor less than one set for each 5,000 sq ft of surface area for slabs or walls. Sets shall be taken by the OWNER (or Inspector) during the progress of work, in compliance with ASTM C31. Specimens shall be formed in 6-in diameter by 12-in long non-absorbent cylindrical molds.

1. A "set" of test cylinders shall consist of five cylinders: one to be tested at seven days, one to be tested at 14 days, and two to be tested and their strengths averaged at 28 days. The fifth may be used for a special test at 3 days or to verify strength after 28 days if 28 day test results are low.

2. When the average 28 day compressive strength of the cylinders in any set falls below the required compressive strength or below proportional minimum seven-day or 14-day strengths (where proper relation between seven, 14 and 28 day strengths have been established by tests), change proportions, cementitious content, or temperature conditions to achieve the required strengths at no additional cost to the OWNER.

C. The CONTRACTOR shall cooperate in the making of tests by allowing free access to the work for selection of samples, providing an insulated and closed, wood or metal curing box for specimens, affording protection to the specimens against injury or loss through the CONTRACTOR's operations and furnish material and labor required for the purpose of taking

concrete cylinder samples. All shipping of specimens will be paid for by the OWNER. The cleanup and disposal of test waste shall be the responsibility of the CONTRACTOR.

D. Slump tests will be made in the field by the Special Inspector immediately prior to placing the concrete. Such tests shall be made in accordance with ASTM C143. When concrete is pumped, slump will be determined at point of truck discharge. Slump test shall be taken for each set of test cylinders defined above. If the slump is outside the specified range, the concrete will be rejected.

E. Air Content: Test for air content shall be made by the Special Inspector on fresh concrete samples. Air content tests shall be taken for each set of test cylinders defined above. Air content for concrete made of ordinary aggregates having low absorption shall be made in compliance with either the pressure method complying with ASTM C231 or by the volumetric method complying with ASTM C173.

F. The OWNER may have cores taken from any questionable area in the concrete work such as construction joints and other locations as required for determination of concrete quality. The results of tests on such cores shall be the basis for acceptance, rejection or determining the continuation of concrete work.

G. The CONTRACTOR shall cooperate in obtaining cores by allowing free access to the work and permitting the use of ladders, scaffolding and such incidental equipment as may be required. The CONTRACTOR shall repair all core holes. The work of cutting and testing the cores will be at the expense of the OWNER.

3.10 FAILURE TO MEET REQUIREMENTS

A. Should the strength by the test specimens made and tested in compliance with the previous provisions fall below the values given in Table 03300-1, the OWNER shall have the right to require changes in the mix design to apply to the remainder of the work. Furthermore the OWNER shall have the right to require additional curing on those portions of the structure represented by the test specimens which failed. The cost of such mix design changes and additional curing shall be at no additional cost to the OWNER. In the event that such additional curing does not give the strength required, as evidenced by core and/or load tests, the OWNER shall have the right to require strengthening or replacement of those portions of the structure which fail to develop the required strength. The cost of all such core borings and/or load tests and any strengthening or concrete replacement required because strengths of test specimens are below that specified, shall be entirely at no additional cost to the OWNER. In such cases of failure to meet strength requirements the CONTRACTOR and OWNER shall confer to determine what adjustment, if any, can be made in compliance with Sections titled “Strength” and “Failure to Meet Strength Requirements” of ASTM C94. The “purchaser” referred to in ASTM C94 is the CONTRACTOR in this Section.

B. When the tests on control specimens of concrete fall below the specified strength, the OWNER will permit check tests for strengths to be made by means of typical cores drilled from the structure in compliance with ASTM C42 and C39. In the case of cores not indicating adequate strength, the OWNER, in addition to other recourses, may require, at no additional cost to the OWNER, load tests on any one of the structural concrete elements such as slabs and walls. Tests need not be made until concrete has aged 60 days.

C. Should the 28-day strength of test cylinders fall below 60 percent of the required minimum 28 day strength, the concrete shall be rejected and shall be removed and replaced.

3.11 PATCHING AND REPAIRS

A. It is the intent of these Specifications to require quality work including forming, mixture and placement of concrete and curing so completed concrete surfaces will require no patching or repairs.

B. Defective concrete as determined by the OWNER shall be repaired as specified in Section 03922 at no additional cost to the OWNER.

C. As soon as the forms have been stripped and the concrete surfaces exposed, fins and other projections shall be removed; recesses left by the removal of form ties shall be filled; and surface defects which do not impair structural strength shall be repaired. Clean exposed concrete surfaces and adjoining work stained by leakage of concrete.

D. Immediately after removal of forms, remove plugs and break off metal form ties. Where tapered ties are NOT used, promptly fill holes upon stripping as follows: Moisten the hole with water, followed by a 1/16-in brush coat of neat cement slurry mixed to the consistency of a heavy paste. Immediately plug the hole with a 1 to 1.5 mixture of cement and concrete sand mixed slightly damp to the touch (just short of "balling"). Hammer the grout into the hole until dense, and an excess of paste appears on the surface in the form of a spiderweb. Trowel smooth with heavy pressure. Avoid burnishing.

E. When patching exposed surfaces, the same source of cement and sand as used in the parent concrete shall be employed. Adjust color if necessary byh addition of proper amounts of white employed. Adjust color if necessary by addition of proper amounts of white cement. Rub lightly with a fine Carborundum stone at an age of 1 to 5 days if necessary to bring the surface down with the parent concrete. Do not damage or stain the surrounding parent concrete. Wash thoroughly to remove all rubbed matter.

F. The CONTRACTOR may use a pre-packaged patching compound, such as: Poly-Patch by Euclid Chemical Company; Emaco R310 by BASF Chemical Company; Sikatop 122 Plus by Sika Chemical Corporation or equal only if approved by the OWNER for use and for color match.

3.12 SCHEDULE

A. The following (Table 03300-4) are the general applications for the various concrete classes and design strengths:

TABLE 03300-4

Class	Design Strength (psi)	Description
A	2,500	Concrete fill, and pipe encasement.
B	3,000	Sidewalks, Pavement, where specified or noted.
D	4,000	Structural concrete, Where specified or noted.

END OF SECTION

SECTION 03350

CONCRETE FINISHING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Concrete finishing

1.02 RELATED WORK

A. Concrete Forms and Accessories is included in Section 03100.

B. Concrete Reinforcement is included in Section 03200.

C. Concrete Joints and Joint Accessories is included in Section 03250.

D. Cast-in-Place Concrete is included in Section 03300.

E. Grout is included in Section 03600.

F. Modifications and Repair to Concrete is included in Section 03922.

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. ASTM C33 - Standard Specification for Concrete Aggregates.

2. ASTM C309 – Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

1.04 SUBMITTALS

A. Product Data: Submit product data showing materials of construction and details of installation for:

1. Concrete sealer: Submit confirmation that the sealer is compatible with other finishes that will be applied to the surfaces.

B. Field Mock-ups: The CONTRACTOR shall prepare the following mock-ups of concrete finishes at the project site for review and approval by the OWNER. Notify the OWNER one week in advance of the preparation of those finishes requiring abrasive blasting. This is to allow the OWNER to review and guide the amount of blast desired. CONTRACTOR shall document methods and tools used to prepare each mock-up so that finishes can be accurately reproduced onto new structures.

1. Sacked Finish -- Prepare a 4 foot wide by 4 foot high by 6-inch thick concrete test panel and mount vertically. This test panel shall be smooth on each side and free of defects. Concrete shall be Class D, per Section 03300. Cast with two tie holes per side, whether ties are required or not. Patch tie holes in accordance with Section 03300. Provide a rubbed finish on one side. When approved by the OWNER, the test panel finish will be used as a standard for this finish on new structures.

1.05 QUALITY ASSURANCE

A. For concrete which will receive additional applied finishes or materials, the surface finish specified is required for the proper application of the specified manufacturer's products. Where alternate products are approved for use, determine if changes in finish are required and provide the proper finish to receive these products.

B. Changes in finish made to accommodate products different from those specified shall be performed at no additional cost to the OWNER. Submit the proposed new finish and their construction methods to the OWNER for approval.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.01 PREPARATION

A. Formed Surfaces

1. Forms shall not be removed before the requirements of Section 03300 have been satisfied.

2. Exercise care to prevent damaging edges or obliterating the lines of chamfers, rustications or corners when removing the forms or performing any other work adjacent thereto.

3. Clean exposed concrete surfaces and adjoining work stained by leakage of concrete. Surfaces to remain exposed showing white surface deposits (calcium carbonate, etc.) shall be cleaned of such deposits until a uniform gray color is achieved.

4. Cure concrete as specified in Section 03300, unless otherwise noted by the OWNER. Modify curing methods to be compatible with the written instructions of special concrete coating manufacturers.

B. Floors and Slabs

1. Immediately after floor or slab placement, screed concrete to the grades and surfaces shown on the Drawings. Complete screeding before any excess moisture or bleeding water is present on the surface.

   a. Level floors and slabs to a tolerance of plus or minus 1/8-in when checked with a 10-ft straightedge placed anywhere on the slab in any direction.

   b. Pitch floors uniformly toward low points, sumps, or drains and as shown on the Drawings, such that there are no low spots left undrained.

   c. At dished floor drains, depress drain inlet one inch, and taper the one inch depression over a two foot radius, unless indicated otherwise.

   d. Failure to meet either of the above requirements shall be cause for removal, grinding, or other correction, as directed by the OWNER.

2. Immediately after final screeding, evenly sprinkle the surface with a dry cement/sand shake in the proportion of two sacks of portland cement to 350 lbs of coarse natural concrete sand at the rate of approximately 500 lbs /1,000 sq ft of floor. Do not sprinkle neat, dry cement on the surface.

   a. The application of the cement/sand shake may be eliminated at the discretion of the OWNER, if the base slab concrete exhibits adequate fattiness and homogeneity and the need is not indicated.

3. Immediately after sprinkling, bull float the surface with a wood float, filling surface voids and slightly embedding the coarse aggregate.

4. After bull floating, defer additional finishing operations until the concrete has stiffened sufficiently to sustain foot pressure with an indentation of not more than 1/4-in.

5. After bleed water and excess moisture has left the surface, edge and joint concrete as specified or shown.

   a. Edge concrete sidewalks, driveways, and steps.

   b. Place tooled joints using a straightedge at locations shown on the Drawings.

6. Water shall not be used to supplement hand or power troweling.

3.02 CONSTRUCTION

A. Rough-Form Finish

1. Immediately after stripping forms and before concrete has changed color, carefully remove fins and projections. Clean surfaces of tie holes. Offset plywood joints shall not exceed 1/8 inch.

2. Promptly fill holes left by tie cones and repair defects as specified in Section 03100 and 03300.

B. Sacked Finish

1. Provide rough-form finish as specified. While the wall is still damp apply a thin coat of medium consistency neat cement slurry by means of bristle brushes to provide a bonding coat within pits, air holes or blemishes in the parent concrete. Avoid coating large areas of the finished surfaces with the slurry at one time.

2. Before the slurry has dried or changed color, apply a dry (almost crumbly) grout proportioned by volume and consisting of 1 part cement to 1-1/2 parts of clean masonry sand having a fineness modulus of approximately 2.3 and complying with the gradation requirements of ASTM C33 for such a material. Uniformly apply grout by means of damp pads of coarse burlap approximately 6-in square used as a float. Scrub grout into the pits and air holes to provide a dense mortar in imperfections.

3. Allow the mortar to partially harden for 1 or 2 hours depending upon the weather. If the air is hot and dry, keep the wall damp during this period using a fine, fog spray. When the grout has hardened sufficiently so it can be scraped from the surface with the edge of a steel trowel without damaging the grout in the small pits or holes, cut off all that can be removed with a trowel.

4. Allow the surface to dry thoroughly and rub it vigorously with clean dry burlap to completely remove any dried grout. No visible film of grout shall remain after this rubbing. The entire cleaning operation for any area must be completed the day it is started. Do not leave grout on surfaces overnight. Allow sufficient time for grout to dry after it has been cut off with the trowel so it can be wiped off clean with the burlap.

5. On the day following the repair of pits, air holes and blemishes, the walls shall again be wiped off clean with dry, used pieces of burlap containing old hardened mortar which will act as a mild abrasive. After this treatment, there shall be no built-up film remaining on the parent surface. If, however, such a film is present, a fine abrasive stone shall be used to remove such material without breaking through the surface film of the original concrete. Such scrubbing shall be light and sufficient only to remove excess material without changing the texture of the concrete.

6. A thorough wash-down with stiff bristle brushes shall follow the final bagging or stoning operation. No extraneous materials shall remain on the surface of the wall. The wall shall be sprayed with a fine fog spray periodically to maintain a continually damp condition for at least 3 days after the application of the repair grout.

C. Floated Finish

1. Float the concrete surface when the water sheen has disappeared and the concrete has hardened sufficiently to support a power float without its digging into or disrupting the surface or a finisher and knee boards with no more than 1/4-in indentation. Start floating along walls and around columns, and in areas most exposed to sun or wind, and then move systematically across the surface leaving a matte finish.

a. Power floats shall be heavy, revolving disk type power compacting machines capable of providing a 200 lb compaction force distributed over a 24-in diameter disk.

b. Troweling machines equipped with float (shoe) blades that are slipped over the trowel blades may be used for floating. However, floating with a troweling machine equipped with normal trowel blades will not be permitted. The use of any floating or troweling machine, which has a water attachment for wetting the concrete surface during finishing, will not be permitted.

c. In lieu of power floating, small areas may be hand floated. While the concrete is still green, but sufficiently hardened to support a finisher and kneeboards with no more than 1/4-in indentation, wood float the surface to a true, even plane with no coarse aggregate visible. Use sufficient pressure on the wood floats to bring moisture to the surface.

2. Restore edging or jointing removed by floating. Maintain joint uniformity and line.

D. Broom Finish

1. Screed and float concrete slabs as specified in the preceding paragraphs. When the concrete has stiffened sufficiently to maintain small surface indentations, draw a bristle broom lightly across the surface in the direction of drainage, or, in the case of walks and stairs, perpendicular to the direction of traffic to provide a non-slip surface.

3.03 APPROVAL OF FINISHES

A. Concrete surfaces, when finished, will be inspected by the OWNER.

B. Surfaces which do not meet the requirements in this Section shall be refinished or reworked.

C. After finishing horizontal surfaces, regardless of the finishing procedure specified, the concrete shall be cured in compliance with Section 03300 unless otherwise directed by the OWNER.

3.04 SCHEDULES

A. Concrete shall be finished as specified either to remain as natural concrete or to receive an additional applied finish or material under another Section.

B. Concrete for the following conditions shall be finished as noted on the Drawings. If not noted on the Drawings concrete shall be finished as follows:

1. Concrete to receive dampproofing or waterproofing: Rough-form finish. See Paragraph 3.2.A.

2. Concrete not exposed to view in the finished work, and not scheduled to receive an additional applied finish or material: Rough-form finish. See Paragraph 3.2.A.

3. Exterior vertical concrete above grade exposed to view (and to 12-in below grade): Sacked finish. See Paragraph 3.2.B.

4. Interior overhead and vertical concrete exposed to view: Sacked finish. See Paragraph 3.2.B.

5. Concrete for exterior walks, interior and exterior stairs: Broomed finish perpendicular to direction of traffic. See Paragraph 3.2.D.

6. Concrete to receive an applied coating: Refer to manufacturer's written directions and on-site direction by manufacturer's representative.

END OF SECTION

SECTION 03600

GROUT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Grout.

1.02 RELATED WORK

A. Grout for jacking and horizontal directional drilling is included in Division 2.

B. Cast-in-place concrete is included in Section 03300.

C. Miscellaneous metals are included in Section 05500.

1.03 SUBMITTALS

A. Submit shop drawings and product data showing materials of construction and details of surface preparation, mixing and installation for:

1. Commercially manufactured non-shrink cementitious grout and self-leveling cementitious underlayment grout. Include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to the specified ASTM standards, and Material Safety Data Sheet.

2. Commercially manufactured non-shrink epoxy grout. Include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to the specified ASTM standards, and Material Safety Data Sheet.

3. Cement grout. Include the type and brand of cement, the gradation of fine aggregate, product data on any proposed admixtures and the proposed grout mix.

4. Concrete grout. Include data as required for concrete as delineated in Section 03300.

B. Samples

1. CONTRACTOR shall submit samples of commercially manufactured grout products that are proposed for use.

2. CONTRACTOR shall submit samples of aggregates that are proposed for use in grout mixes.

C. Laboratory Test Reports

1. For concrete grout, submit laboratory test data as required for concrete as delineated in Section 03300.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM C33 - Standard Specification for Concrete Aggregates

2. ASTM C150 - Standard Specification for Portland Cement

3. ASTM C827 - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures

4. ASTM C1077 - Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation

5. ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink)

6. ASTM E329 - Standard specification for agencies engaged in the testing and/or inspection of materials used in construction

1.05 QUALITY ASSURANCE

A. Field Testing

1. Field testing of concrete grout will be as specified for concrete in Section 03300.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the jobsite in original, unopened packages, clearly labeled with the manufacturer's name, product identification, batch numbers and printed instructions.

B. Store materials in full compliance with the manufacturer's recommendations. Limit total storage time from date of manufacture to date of installation to six months or the manufacturer's recommended storage time, whichever is less.

C. Remove immediately from the site material which becomes damp, contains lumps, or is hardened and replace with acceptable material at no additional cost to the OWNER.

D. Deliver non-shrink cementitious grout and self-leveling cementitious underlayment grout as a pre-portioned blend in prepackaged mixes requiring only the addition of water.

1.07 DEFINITIONS

A. Non-shrink Grout: A commercially manufactured product that does not shrink in either the plastic or hardened state, is dimensionally stable in the hardened state and bonds to a clean base plate.

B. Self-Leveling Cementitious Underlayment Grout: A commercially manufactured Portland cement based, non-shrinking, self-leveling underlayment.

PART 2 PRODUCTS

2.01 GENERAL

A. The use of a manufacturer's name and product or catalog number is for the purpose of establishing the standard of quality desired.

B. Like materials shall be the products of one manufacturer or supplier in order to provide standardization of appearance.

2.02 MATERIALS

A. Non-shrink Cementitious Grout

1. Non-shrink cementitious grouts: Conform to ASTM C1107. Grouts shall be portland cement based, contain a pre-proportioned blend of selected aggregates and shrinkage compensating agents and require only the addition of water. Non-shrink cementitious grouts shall not contain expansive cement or metallic particles. The grouts shall exhibit no shrinkage when tested in conformity with ASTM C827.

   a. General purpose non-shrink cementitious grout: Conform to the standards stated above. SikaGrout 212 by Sika Corp.; Set Grout by BASF Building Systems; NS Grout by The Euclid Chemical Co.; or equal.

   b. Flowable (Precision) non-shrink cementitious grout: Conform to the standards stated above. Masterflow 928 by BASF Building Systems; Hi-Flow Grout by The Euclid Chemical Co.; SikaGrout 212 by Sika Corp.; or equal.

B. Cement Grout

1. A mixture of one part portland cement conforming to ASTM C150, Type I, II, or III and one to two parts sand conforming to ASTM C33 with sufficient water to place the grout. The water content shall be sufficient to impart workability to the grout but not to the degree that it will allow the grout to flow.

C. Concrete Grout

1. Concrete grout shall conform to the requirements of Section 03300 except as specified herein. It shall be proportioned with cement, coarse and fine aggregates, water, water reducer and air entraining agent to produce a mix having a nominal compressive strength of 2500 psi at 28 days. Coarse aggregate size shall be 3/8-in maximum. Slump should not exceed 5-in and should be as low as practical yet still retain sufficient workability.

D. Water

1. Potable water free of oil, acid, alkali, salts, chlorides (except those attributable to drinking water), organic matter, or other deleterious substances.

PART 3 EXECUTION

3.01 PREPARATION

A. Grout shall be placed where indicated or specified over cured concrete which has attained its specified design strength unless otherwise approved by the OWNER.

B. Concrete surfaces to receive grout shall be clean and sound; free of ice, frost, dirt, dust, grease, oil, form release agent, laitance and paints and free of loose material or foreign matter which may affect the bond or performance of the grout.

C. Roughen concrete surfaces by chipping, sandblasting, or other dry mechanical means to bond the grout to the concrete. Remove loose or broken concrete. Irregular voids or projecting coarse aggregate need not be removed if they are sound, free of laitance and firmly embedded into the parent concrete.

   1. Air compressors used to clean surfaces in contact with grout shall be the oilless type or equipped with an oil trap in the airline to prevent oil from being blown onto the surface.

D. Remove loose rust, oil or other deleterious substances which may affect the bond or performance of the grout from metal embedments or bottom of baseplates prior to the installation of the grout.

E. Concrete surfaces shall be washed clean and then keep moist for at least 24 hours prior to the placement of non-shrink cementitious or cement grout. Saturation may be achieved by covering the concrete with saturated burlap bags, use of a soaker hose, flooding the surface, or other method acceptable to the OWNER. Upon completion of the 24 hour period, visible water shall be removed from the surface prior to grouting. The use of an adhesive bonding agent in lieu of surface saturation shall only be used when approved by the OWNER for each specific location of grout installation.

F. Provide forms for grout or other leakproof containment as required. Forms shall be lined or coated with release agents recommended by the grout manufacturer. Forms shall be of adequate strength, securely anchored in place and shored to resist the forces imposed by the grout and its placement.

   1. Forms for grout other than concrete grout shall be designed to allow the formation of a hydraulic head and shall have chamfer strips built into forms.

G. Level and align the structural or equipment bearing plates in accordance with the structural requirements or the recommendations of the equipment manufacturer, as applicable.

H. Support equipment during alignment and installation of grout by shims, wedges, blocks or other approved means. The shims, wedges and blocking devices shall be prevented from bonding to the grout by bond breaking coatings and removed after grouting unless otherwise approved by the OWNER. Grout voids created by the removal of shims, wedges and blocks.

3.02 INSTALLATION - GENERAL

A. Mix, apply and cure products in strict compliance with the manufacturer's recommendations and these specifications.

B. Provide staffing and equipment available for rapid and continuous mixing and placing. Keep necessary tools and materials ready and close at hand.

C. Maintain temperatures of the base plate, supporting concrete, and grout between 40 and 90 degrees F during grouting and for at least 24 hours after placement, until grout compressive strength reaches 1000 psi or as recommended by the grout manufacturer, whichever is longer. Take precautions to minimize differential heating or cooling of baseplates and grout during the curing period.

D. Take special precautions for hot weather or cold weather grouting as recommended by the manufacturer when ambient temperatures and/or the temperature of the materials in contact with the grout are outside of the 40 to 90 degrees F range.

E. Install grout in a manner which will preserve the isolation between the elements on either side of the joint where grout is placed in the vicinity of an expansion or control joint.

F. Reflect existing underlying expansion, control and construction joints through the grout.

3.03 INSTALLATION - NON-SHRINK CEMENTITIOUS GROUTS AND CEMENT GROUTS

A. Mix in accordance with manufacturer's recommendations. Do not add cement, sand, pea gravel or admixtures without prior approval of the OWNER.

B. Do not mix by hand. Mix in a mortar mixer with moving blades. Pre-wet the mixer and empty excess water. Add pre-measured amount of water for mixing, followed by the grout. Begin with the minimum amount of water recommended by the manufacturer and then add the minimum additional water required to obtain workability. Do not exceed the manufacturer's maximum recommended water content.

C. Placements greater than 3-in in depth shall include the addition of clean, washed pea gravel to the grout mix when approved by the manufacturer. Comply with the manufacturer's recommendations for the size and amount of aggregate to be added.

D. Place grout into the designated areas and prevent segregation and entrapment of air. Do not vibrate grout to release air or to consolidate the material. Placement should proceed in a manner which will ensure the filling of spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes and vent holes as necessary.

E. Place grout rapidly and continuously to avoid cold joints. Do not place grout in layers. Do not add additional water to the mix (retemper) after initial stiffening.

F. Just before the grout reaches its final set, cut back the grout to the substrate at a 45 degree angle from the lower edge of bearing plate unless otherwise ordered and approved by the OWNER. Finish this surface with a wood float or brush finish.

G. Begin curing immediately after form removal, cutback, and finishing. Keep grout moist and within its recommended placement temperature range for at least 24 hours after placement, until or longer if recommended by the manufacturer. Saturate the grout surface by use of saturated burlap bags, soaker hoses or ponding. Provide sunshades. If drying winds inhibit the ability of a given curing method to keep grout moist, erect wind breaks until wind is no longer a problem or curing is finished.

3.04 SCHEDULE

A. The following list indicates where the particular types of grout are to be used:

1. General purpose non-shrink cementitious grout: Use at locations where non-shrink grout is indicated on the Drawings, except for base plates greater in area than 3-ft wide by 3-ft long.

2. Flowable (precision) non-shrink cementitious grout: Use under base plates greater in area than 3-ft wide by 3-ft long. Use at locations indicated on the Drawings to receive flowable non-shrink grout. Flowable (precision), non-shrink, cementitious grout may be substituted for general purpose non-shrink cementitious grout.

3. Cement grout: Use where indicated on the Drawings.

END OF SECTION

SECTION 03650

CONTROLLED DENSITY FILL

PART 1 GENERAL

1.01.1 SUMMARY

A. Section includes:

1. Controlled density fill.

1.02 RELATED WORK

A. Trenching, Backfilling & Compaction are included in Section 02221.

B. Cast-in-Place Concrete is included in Section 03300.

1.03 SUBMITTALS

A. Submit shop drawings and product data. Submittals shall include the following:

1. Constituent quantities per cubic yard of the controlled density fill mix including water content, cement factor, type and amount of fly ash and type and manufacturer of cement.

2. Technical data on materials and components.

B. Test Reports

1. Sieve analysis of aggregate.

2. Laboratory test results of the compressive strength of the proposed mix.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM C33 - Standard Specification for Concrete Aggregates.

2. ASTM C94 - Standard Specification for Ready-Mixed Concrete.

3. ASTM C143 - Standard Test Method for Slump of Hydraulic Cement Concrete.

4. ASTM C150 - Standard Specification for Portland Cement.

5. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.

6. ASTM D4832 - Standard Test Method for Preparation and Testing of Controlled Low Strength Material Test Cylinders.

B. American Concrete Institute (ACI).

1. ACI 301 - Standard Specification for Structural Concrete.

1.05 QUALITY ASSURANCE

A. Testing necessary to establish the mix shall be performed by and at the expense of the CONTRACTOR. Methods of testing shall comply with the applicable ASTM Methods except as specified herein.

1.06 DELIVERY, STORAGE AND HANDLING

A. Products shall be stored in conformity with the manufacturer's recommendations.

B. Fly ash, aggregate and cement shall be stored or stockpiled in conformity with the recommendations of ACI 301.

PART 2 PRODUCTS

2.01 MATERIALS

A. Cement shall be domestic portland cement conforming to ASTM C150, Type II. The minimum cement content shall be 100 lbs/cu yd.

B. Fly ash shall conform to ASTM C618 Class F. The minimum fly ash content shall be 300 lbs/cu yd.

C. Aggregate shall be inert natural sand conforming to the requirements of ASTM C33 or inert natural sand containing aggregate sizes not greater than 3/8-in and having given satisfactory density, strength and setting time when used in comparable controlled density fill mixes. Aggregates shall not be expansive or reactive.

D. Water shall be potable, clean and free from injurious amounts of oils, acids, alkalis, organic matter, or other deleterious substances. The water content of the mix may be approximately 400 lbs/cu yd.

E. Admixtures manufactured specifically manufactured for use in controlled density fills will be considered for approval. Admixtures shall be free of chlorides and alkalis (except for those attributable to water). Admixtures shall be compatible with the mix and shall be suitable for use in contact with potable water after curing. Admixtures causing retarded or accelerated setting of the mix shall not be used without written approval from the OWNER.

2.02 MIXES

A. Select proportions of ingredients to meet the minimum design strength of 300 psi and to produce a fill having proper placability, durability and strength. Proportion ingredients to produce a homogenous mixture which will readily work into corners and angles without permitting materials to segregate.

B. Compression Tests: Furnish testing of the proposed mix to demonstrate compliance with the compression strength requirements.

C. Slump of the mix, as measured by ASTM C143, shall be approximately 8-in.

2.03 MEASURING, BATCHING, MIXING AND TRANSPORTING

A. Measuring, batching, mixing and transporting shall conform to ASTM C94 and the requirements herein or as otherwise approved in writing by the OWNER.

B. Ready-mixed controlled density fill, whether produced by a concrete supplier or the CONTRACTOR shall conform to the requirements above. No hand mixing will be permitted.

C. The controlled density fill shall be mixed until there is uniform distribution of the materials and shall be discharged completely before the mixer is recharged. Fill which has been remixed or retempered shall be rejected.

PART 3 EXECUTION

3.01 INSPECTION AND COORDINATION

A. The batching, mixing, transporting and placing and of the controlled density fill shall be subject to the inspection of the OWNER at any time. No placement shall be made without the inspection and acceptance of the preparations by the OWNER.

3.02 APPEARANCE

A. The controlled density fill shall have a homogeneous structure which, when hardened, will have the required strength and durability.

3.03 PLACING

A. No controlled density fill shall be placed until the condition of subgrade and method(s) of placement have been approved by the OWNER. Before depositing controlled density fill, debris and foreign matter shall be removed from the excavation. Controlled density fill shall not be placed in water or submerged within 24 hours after placing, nor shall running water be permitted to flow over the surface of fresh controlled density fill.

B. Deposit the mix as near its final position as possible to avoid segregation due to rehandling or flowing. Pumping of the mix will be permitted when the approved design mix is based on pumping. Do not deposit concrete which has partially hardened or has been contaminated by foreign materials.

3.04 CURING AND PROTECTION

A. Protect controlled density fill against injury from the elements and damage of any nature during construction operations.

B. Controlled density fill placed during cold weather shall be protected against freezing. Salt, manure or other chemicals shall not be used for cold weather protection.

3.05 FIELD TESTS

A. Sets of 6-in by 12-in test cylinders will be taken of the work by the construction manager following the procedures given in ASTM D4832. The number of sets of test cylinders shall be at the discretion of the construction manager. The cylinders shall be capped with neoprene for testing. When the average compressive strength of the cylinders in any set falls below the required compressive strength; the construction manager may reject the fill represented by the set of cylinders or require modification of the proportions of the design mix to achieve the required strengths.

B. Cooperate in the making of tests by allowing free access to the work for the selection of samples, providing an insulated closed curing box for specimens, affording protection to the specimens against injury or loss through the operations and furnishing material and labor required for the purpose of taking test cylinder samples.

C. Slump tests will be made in the field by the construction manager in conformity with ASTM C143.

END OF SECTION

SECTION 03922

MODIFICATIONS AND REPAIR TO CONCRETE

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Cutting, removing, repairing or otherwise modifying parts of existing concrete structures or appurtenances as shown on the Drawings and as specified herein. Work under this Section shall also include bonding new concrete to existing concrete.

B. In general, work under this Section will be performed as a remedy for improperly placed or poorly placed concrete as identified by the OWNER. Such work shall be performed only after receiving written directions from the OWNER. Remedies for improperly placed or poorly placed concrete shall be performed at no additional cost to the OWNER.

1.02 RELATED WORK

A. Concrete Forms and Accessories is included in Section 03100.

B. Concrete Reinforcement is included in Section 03200.

C. Concrete Joints and Joint Accessories is included in Section 03250.

D. Cast-in-Place Concrete is included in Section 03300.

E. Grout is included in Section 03600.

F. Metal Fabrications is included in Section 05500.

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM)

1. ASTM C881 - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.

2. ASTM C882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Sheer.

3. ASTM C883 - Standard Test Method for Effective Shrinkage of Epoxy-Resin Systems Used with Concrete.

4. ASTM D570 - Standard Test Method for Water Absorption of Plastics.

5. ASTM D638 - Standard Test Method for Tensile Properties of Plastics.

6. ASTM D695 - Standard Test Method for Compressive Properties of Rigid Plastics.

7. ASTM D732 - Standard Test Method for Shear Strength of Plastics by Punch Tool.

8. ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

B. International Concrete Repair Institute (ICRI):

1. ICRI Guideline No. 03732 – Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.

1.04 SUBMITTALS

A. Submit a Schedule of Demolition and the detailed methods of demolition to be used at each location.

B. Submit manufacturer's technical literature on product brands proposed for use, to the OWNER for review. The submittal shall include the manufacturer's installation and/or application instructions.

1.05 QUALITY ASSURANCE

A. No existing structure or concrete shall be shifted, cut, removed, or otherwise altered until authorization is given by the OWNER.

B. When removing materials or portions of existing structures and when making openings in existing structures, precautions shall be taken and necessary barriers, shoring and bracing and other protective devices shall be erected to prevent damage to the structures beyond the limits necessary for the new work, protect personnel, control dust and to prevent damage to the structures or contents by falling or flying debris. Unless otherwise permitted, shown or specified, line drilling will be required in cutting existing concrete.

C. Furnish a notarized certificate stating that the materials specified meet the requirements and have the manufacturer's current printed literature on the specified product.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver the specified products in original, unopened containers with the manufacturer's name, labels, product identification and batch numbers.

B. Store and condition the specified product as recommended by the manufacturer.

PART 2 PRODUCTS

2.01 MATERIALS

A. General

1. Materials shall comply with this Section and any state or local regulations.

B. Epoxy Bonding Agent

1. General

a. The epoxy bonding agent shall be a two-component, solvent-free, asbestos-free moisture insensitive epoxy resin material used to bond plastic concrete to hardened concrete complying with the requirements of ASTM C881, Type II and the additional requirements specified herein.

2. Material

a. Properties of the cured material:

1) Compressive Strength (ASTM D695): 8500 psi minimum at 28 days.

2) Tensile Strength (ASTM D638): 4000 psi minimum at 14 days.

3) Flexural Strength (ASTM D790 - Modulus of Rupture): 6,300 psi minimum at 14 days.

4) Shear Strength (ASTM D732): 5000 psi minimum at 14 days.

5) Water Absorption (ASTM D570 - 2 hour boil): One percent maximum at 14 days.

6) Bond Strength (ASTM C882) Hardened to Plastic: 1500 psi minimum at 14 days moist cure.

7) Effective Shrinkage (ASTM C883): Passes Test.

8) Color: Gray.

3. Approved manufacturers include: Sika Corporation, Lyndhurst, NJ - Sikadur 32, Hi-Mod; BASF, Florham Park, NJ - Concresive Liquid (LPL) or equal.

C. Epoxy Paste

1. General

a. Epoxy Paste shall be a two-component, solvent-free, asbestos free, moisture insensitive epoxy resin material used to bond dissimilar materials to concrete such as setting railing posts, dowels, anchor bolts and all-threads into hardened concrete

and shall comply with the requirements of ASTM C881, Type I, Grade 3 and the additional requirements specified herein. It may also be used to patch existing surfaces where the glue line is 1/8-in or less.

2. Material

a. Properties of the cured material:

1) Compressive Properties (ASTM D695): 10,000 psi minimum at 28 days.

2) Tensile Strength (ASTM D638): 3,000 psi minimum at 14 days. Elongation at Break - 0.3 percent minimum.

3) Flexural Strength (ASTM D790 - Modulus of Rupture): 3,700 psi minimum at 14 days.

4) Shear Strength (ASTM D732): 2,800 psi minimum at 14 days.

5) Water Absorption (ASTM D570): 1.0 percent maximum at 7 days.

6) Bond Strength (ASTM C882): 2,000 psi at 14 days moist cure.

7) Color: Concrete gray.

3. Approved manufacturers include:

a. Overhead applications: Sika Corporation, Lyndhurst, NJ - Sikadur Hi-mod LV 31; BASF, Florham Park, NJ - Concresive 1438 or equal.

b. Sika Corporation, Lyndhurst, N.J. - Sikadur Hi-mod LV 32; BASF, Florham Park NJ - Concresive 1438 or equal.

D. Non-Shrink Precision Cement Grout, Non-Shrink Cement Grout, are included in Section 03600.

E. Sealant

1. Polyurethane elastomeric sealants shall be two-component, self-leveling or non-sag as required by the application. Sealant shall produce a tough, flexible, long-lasting seal with excellent adhesion, elasticity, tear resistance and abrasion resistance. Sealant shall resist deterioration caused by weather, joint movement, pedestrian and vehicular traffic, oils, dilute acids and dilute alkalines. The sealant shall be designed for a maximum joint movement of plus or minus 50 percent of the joint width. Self-leveling sealants may be used in horizontal joints and non-sag sealants can be used in horizontal and vertical joints. Colors for sealants shall be selected by the OWNER from standard colors. Allow for up to three colors to be selected. Sealant shall be Sikaflex 2C NS (non-sag) or SL (self-leveling) by Sika Corp., Lyndhurst, NJ, or approved equal.

2. Use a manufacturer-recommended epoxy based primer prior to installing sealant in joints. Primer shall be Sikaflex 429 by Sika Corp., Lyndhurst, NJ, or approved equal.

F. Cement crack repair compound

1. Cement crack repair compound shall be a non-shrink, high-bond-strength, hydraulic cement crystalline waterproofing compound for concrete patching and repair. It shall have a minimum compressive strength of 2,100 psi at 24 hours and 4,500 psi at 28 days. Repair compound shall be Xypex Patch’n Plug by Xypex Chemical Corporation, Richmond, BC, Canada, or approved equal.

G. Cementitious repair mortar

1. For shallow repairs of vertical or overhead concrete surfaces, cementitious repair mortar shall be a two-component, polymer-modified, portland cement, fast-setting, non-sag mortar and shall contain a penetrating corrosion inhibitor. Repair mortar shall be Sikatop 123 PLUS by Sika Corp., Lyndhurst, NJ, or approved equal.

2. For deeper repairs of horizontal, vertical or overhead concrete surfaces, cementitious repair mortar shall be a two-component, polymer-modified, portland cement, fast-setting, screed mortar and shall contain a penetrating corrosion inhibitor and. The repair mortar may be extended with 3/8-in coarse aggregate in accordance with manufacturer’s recommendations, and may be used in a form and pour application. Repair mortar shall be Sikatop 111 PLUS by Sika Corp., Lyndhurst, NJ, or approved equal.

PART 3 EXECUTION

3.01 GENERAL

A. Modify and/or repair concrete as specified herein, or necessary to permit completion of the Work, and as directed by the OWNER. Finishes, joints, reinforcements, sealants, etc, are specified in respective Sections. Work shall comply with other requirements of this of Section and as shown on the Drawings.

B. Commercial products specified in this Section shall be stored, mixed and applied in strict compliance with the manufacturer's recommendations.

C. In cases where concrete is repaired in the vicinity of an expansion joint or control joint the repairs shall be made to preserve the isolation between components on either side of the joint.

D. When drilling holes for dowels/bolts at new or existing concrete, drilling shall stop if rebar is encountered. As approved by the OWNER, the hole location shall be relocated to avoid rebar. Rebar shall not be cut without prior approval by the OWNER. Where possible, rebar locations shall be identified prior to drilling using "rebar locators" so that drilled hole locations may be adjusted to avoid rebar interference.

3.02 CONCRETE REMOVAL

A. Concrete designated to be removed to specific limits as shown on the Drawings or directed by the OWNER, shall be done by line drilling at limits followed by chipping or jack-hammering as appropriate in areas where concrete is to be taken out. Remove concrete in such a manner

that surrounding concrete or existing reinforcing to be left in place and existing in place equipment is not damaged. Sawcutting at limits of concrete to be removed shall only be done if indicated on the Drawings, or after obtaining written approval from the OWNER. When sawcutting is performed, do not overcut corners.

B. Where existing reinforcing is exposed due to saw cutting/core drilling and no new material is to be placed on the sawcut surface, a coating or surface treatment of epoxy paste shall be applied to the entire cut surface to a thickness of 1/4-in.

C. In cases where the joint between new concrete or grout and existing concrete will be exposed in the finished work, except as otherwise shown or specified, the edge of concrete removal shall be a 1-in deep saw cut on each exposed surface of the existing concrete.

D. Concrete specified to be left in place which is damaged shall be repaired by approved means to the satisfaction of the OWNER.

E. The OWNER may from time to time direct the CONTRACTOR to make additional repairs to existing concrete. These repairs shall be made as specified or by such other methods as may be appropriate.

3.03 CONNECTION SURFACE PREPARATION

A. Connection surfaces shall be prepared as specified below for concrete areas requiring patching, repairs or modifications as shown on the Drawings, specified herein, or as directed by the OWNER.

B. Remove deteriorated materials, dirt, oil, grease, and other bond inhibiting materials from the surface by dry mechanical means, i.e. - sandblasting, grinding, etc, as approved by the OWNER. Be sure the areas are not less than 1/2-in in depth. Irregular voids or surface stones need not be removed if they are sound, free of laitance, and firmly embedded into parent concrete, subject to the OWNER's final inspection. Surfaces that will be in contact with freshly placed concrete shall be roughened to minimum Concrete Surface Profile (CSP) 9 per ICRI Guideline 03732 with minimum 1/4-in amplitude.

C. If reinforcing steel is exposed, it must be mechanically cleaned to remove contaminants, rust, etc, as approved by the OWNER. If half of the diameter of the reinforcing steel is exposed, chip out behind the steel. The distance chipped behind the steel shall be a minimum of 1/2-in. Reinforcing to be saved shall not be damaged during the demolition operation.

D. Reinforcing from existing demolished concrete which is shown to be incorporated in new concrete shall be cleaned by mechanical means to remove loose material and products of corrosion before proceeding with the repair. It shall be cut, bent or lapped to new reinforcing as shown on the Drawings and provided with 1-in minimum cover around.

E. Saturate the surface 12 hours before and again immediately prior to concrete or grout mixture placement.

3.04 GROUTING

A. Grouting shall be as specified in Section 03600.

3.05 CRACK REPAIR

A. Concrete cracks greater than 0.020-in in width shall be repaired as directed by the OWNER.

3.06 HONEYCOMBING / ROCK POCKETS

A. Defective and honeycombed areas as determined by the OWNER shall be repaired.

1. Remove honeycomb and defective concrete to sound concrete and 1-inch minimum depth. The sides of removal and repair areas shall be square.

2. Roughen surface by bushhammering or chiseling to minimum Concrete Surface Profile (CSP) 9 per ICRI Guideline 03732 with minimum 1/4-in amplitude.

3. Thoroughly clean the surface of loose or weakened materials by waterblasting (preferable) or sandblasting.

4. 12 hours before and again immediately prior to the concrete or mortar being deposited, saturate the joints and adjacent concrete surfaces to at least 12-in past the joint with water.

5. Pack the void with either 4,000 psi concrete using ½-in maximum rock size, SikaTop 123 PLUS (or approved equal), or SikaTop 111 PLUS (or approved equal) extended with aggregate as allowed per the Manufacturer's recommendations.

6. A form and pour application using a bird's mouth may be used pending written approval by the OWNER. Submit repair method for approval.

END OF SECTION

DIVISION 5

METALS

SECTION 05500

MISCELLANEOUS METAL

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Metal furnishings.
2. Anchor bolts and fastening devices.
3. Castings
4. Prefabricated access hatches.
5. Metal grating.

1.02 RELATED WORK

A. Painting is included in Division 9.

1.03 SUBMITTALS

A. Submit shop drawings and product data showing materials of construction and details of installation for:

1. Shop drawings, showing sizes of members, method of assembly, anchorage and connection to other members.
2. Prefabricated access hatch.

B. Samples

1. Submit samples as requested by the OWNER during the course of construction.

C. Design Data

1. Submit manufacturer's load and deflection tables for grating.

D. Test Reports

1. Certified copy of mill test reports on each steel proposed for use showing the physical properties and chemical analysis.

1.04 REFERENCE STANDARDS

A. Aluminum Association (AA)

1. AA M31C22A41

a. M31: Mechanical Finish, Fine Satin

b. C22: Finish, Medium Matte

c. A41: Clear Anodic Coating, Class I

B. American National Standards Institute (ANSI) and National Association of Architecture Metal Manufacturers (NAAMM):

1. ANSI/NAAMM MBG 531 – Metal Bar Grating Manual

C. American Society for Testing and Materials (ASTM)

1. ASTM A36 - Standard Specification for Carbon Structural Steel.

2. ASTM A48 - Standard Specification for Gray Iron Castings.

3. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

4. ASTM A108 - Standard Specification for Steel Bars, Carbon, Cold Finished, Standard Quality.

5. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

6. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

7. ASTM A240 - Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Plate, Sheet, and Strip Pressure Vessels.

8. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes.

9. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 Psi Tensile Strength.

10. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

11. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

12. ASTM A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.

13. ASTM A536 - Standard Specification for Ductile Iron Castings.

14. ASTM A570 - Standard Specification for Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality.

15. ASTM A1008 - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.

16. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

17. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes.

18. ASTM B429 - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.

19. ASTM F1554 -Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

20. ASTM F2329 - Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon Screws, Washers, Nuts, and Special Threaded Fasteners

D. American Institute of Steel Construction (AISC)

1. Specification for Structural Steel Buildings – Allowable Stress Design and Plastic Design.

E. American Welding Society (AWS)

1. AWS D1.1 - Structural Welding Code - Steel.

2. AWS D1.2 - Structural Welding Code - Aluminum.

3. AWS D1.6 - Structural Welding Code - Stainless Steel

F. Federal Specifications

1. FS-FF-B-575C - Bolts, Hexagonal and Square

G. Occupational Safety and Health Administration (OSHA)

1.05 QUALITY ASSURANCE

A. The work of this Section shall be completely coordinated with the work of other Sections. Verify, at the site, both the dimensions and work of other trades adjoining items of work in this Section before fabrication and installation of items herein specified.

B. Furnish items included under this Section that are to be built into the work of other Sections.

C. Welding shall be performed by qualified welders and shall conform to the applicable AWS welding code. Welding of steel shall conform to AWS D1.1 and welding of aluminum shall conform to AWS D1.2 and welding of stainless steel shall conform to AWS D1.6.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver items to be incorporated into the work of other Sections in sufficient time to be checked prior to installation.

B. Store materials on skids and not on the ground and block up so that they will not become bent or otherwise damaged. Handle materials with cranes or derricks. Do not dump material off cars or trucks nor handle in any other way that will cause damage.

C. Repair items that have become damage or corroded to the satisfaction of the OWNER prior to incorporating them into the work.

1.07 PROJECT/SITE REQUIREMENTS

A. Field measurements shall be taken at the site, prior to fabrication of items, to verify or supplement indicated dimensions and to ensure proper fitting of items.

PART 2 PRODUCTS

2.01 GENERAL

A. Like items of materials shall be the end products of one manufacturer in order to provide standardization for appearance, maintenance and manufacturer's service.

2.02 MATERIALS

A. Unless otherwise noted, materials for miscellaneous metals shall conform to the following standards:

1.	Structural Steel	Wide flange shapes: ASTM A992 Other shapes; plates; rods and bars: ASTM A36
2.	Structural Steel Tubing	ASTM A500, Grade B
3.	Welded and Seamless Steel Pipe	ASTM A501 or ASTM A53, Type E or S, Grade B Schedule 40. Use standard malleable iron fittings, galvanized for exterior work
4.	Steel Sheets	ASTM A1008
5.	Gray Iron Castings	ASTM A48, Class 35
6.	Ductile Iron Castings	ASTM A536, Grade 65-45-12

7. Aluminum Extruded Pipe	ASTM B429, Alloy 6063 T6 and Alloy 6061 T6 as indicated
8. Aluminum Extruded Shapes	ASTM B221, Alloy 6061 T6
9. Aluminum Sheet and Plate	ASTM B209, Alloy 6061 T6
10. Stainless Steel Plates, Sheets, and Structural Shapes	
a. Exterior, Submerged or Industrial Use	ASTM A240, Type 316 (Type 316L for welded)
b. Interior and Architectural Use	ASTM A240, Type 304
11. Stainless Steel Bolts, Nuts, and Washers	ASTM A276, Type 316
12. Carbon Steel Bolts and Studs	ASTM A307, Grade A (hot dip galvanized nuts and washers where noted)
13. High Strength Steel Bolts, Nuts and washers	ASTM A325 (mechanically galvanized per ASTM B695, Class 50, where noted)
a. Elevated Temperature Exposure	Type I
b. General Application	Type I or Type II
14. Galvanizing	ASTM A123, Zn w/0.05 percent minimum Ni
15. Galvanizing, hardware	ASTM A153, Zn w/0.05 percent minimum Ni
16. Galvanizing, anchor bolts	ASTM F2329, Zn w/0.05 percent minimum Ni
17. Welding electrodes, steel	AWS A5.1 E70xx

2.03 ANCHORS, BOLTS AND FASTENING DEVICES

A. Furnish anchors, bolts, fasteners, etc, as necessary for installation of the work or for securing the work of other Sections to in-place construction.

B. The bolts used to attach the various members to the anchors shall be the sizes shown or required. Attach aluminum and stainless steel to concrete or masonry by means of stainless steel bolts. Attach iron or steel with steel bolts unless otherwise specifically noted.

C. Bolt heads and nuts shall be hex type unless noted otherwise.

D. For structural purposes, unless otherwise noted, drilled-in concrete anchors shall be adhesive type or expansion type anchor bolts. Drilled-in anchors shall have ICC or IAPMO certified permissible values.

1. Concrete adhesive anchors shall be a two-part stud and cartridge resin anchoring system certified for use in cracked concrete. Stud assembly spacing and minimum embedment shall be as shown on the Drawings. The assembly shall include all-thread anchor rod with nut and washer, or deformed reinforcing steel complying with the requirements of Section 03200. Provide manufacturer's recommended drive units and adaptors for installing studs. Install anchors in full compliance with the manufacturer's recommendations. Adhesive anchors for use in concrete shall be Hilti HIT-RE 500-SD by Hilti, Inc., Tulsa OK; Simpsons SET-XP by Simpson Strong-Tie Company, Inc., Pleasanton, CA; or approved equal.

2. Concrete expansion anchors shall be wedge type anchors certified for use in cracked concrete. Anchors shall be of the sizes noted on the Drawings complete with nuts and washers. Unless otherwise noted, provide zinc plated carbon steel anchors. Stainless steel anchors, where required shall be all AISI Type 316 construction. When the length or embedment of the bolt is not noted on the Drawings, provide length sufficient to place the wedge and expansion sleeve portion of the bolt at least one inch behind the reinforcing steel within the concrete. Expansion anchors shall be Hilti Kwik-Bolt TZ by Hilti, Inc., Tulsa OK; Simpsons Strong-Bolt 2 Wedge Anchors for Cracked and Uncracked Concrete by Simpsons Strong-Tie Company, Inc., Pleasanton, CA; or approved equal.

E. Headed anchor studs shall be flux ended, welded to plates or other embeds as shown on the Drawings. Studs shall be made from cold drawn steel Grades C-1010 through C-1020 per ASTM A108 and shall be welded per the manufacturer's recommendations. Headed anchor studs shall be Nelson Stud Welding Company, Loraine, OH - Type H4L or S3L, or equal.

2.04 MISCELLANEOUS ALUMINUM

A. Miscellaneous metal work shall be formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Holes shall be drilled or punched. Edges shall be smooth and without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitely shown or specified.

B. Connections and accessories shall be of sufficient strength to safely withstand the stresses and strains to which they will be subjected. Exposed joints shall be close fitting and jointed where least conspicuous. Threaded connections shall have the threads concealed where practical. Welded connections shall have continuous welds or intermittent welds as specified or shown. The face of welds shall be dressed flush and smooth. Welding shall be on the unexposed side as much as possible in order to prevent pitting or discoloration of the aluminum exposed surface. Provide holes for temporary field connections and for attachment of the work of other trades.

C. Miscellaneous aluminum items shall include any other miscellaneous aluminum called for on the Drawings and not otherwise specified.

D. Aluminum shall be given an anodic oxide treatment in accordance with the AA M31C22A41. Other aluminum items shall have a cleaned and degreased mill finish.

2.05 MISCELLANEOUS STEEL

A. Miscellaneous metal work shall be formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Holes shall be drilled or punched. Edges shall be smooth and without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitely shown or specified.

B. Connections and accessories shall be of sufficient strength to safely withstand the stresses and strains to which they will be subjected. Exposed joints shall be close fitting and jointed where least conspicuous. Threaded connections shall have the threads concealed where practical. Welded connections shall have continuous welds or intermittent welds as specified or shown. The face of welds shall be dressed flush and smooth. Provide holes for temporary field connections and for attachment of the work of other trades.

C. Miscellaneous steel items shall include any miscellaneous steel called for on the Drawings and not otherwise specified.

D. Steel pipe pieces for sleeves, lifting attachments and other functions shall be Schedule 40 pipe unless otherwise shown on the Drawings. Wall and floor sleeves, of steel pipe, shall have welded circumferential steel waterstops at mid-length.

E. Steel finish work shall be thoroughly cleaned, by effective means, of loose mill scale, rust and foreign matter and shall be given one shop coat of primer compatible with the finish coat after fabrication but before shipment. Paint shall be omitted within 3-in of proposed field welds. Paint shall be applied to dry surfaces and shall be thoroughly and evenly spread and well worked into joints and other open spaces.

F. Galvanizing, where required, shall be the hot-dip zinc process after fabrication. Coating shall be not less than 2 oz/sq ft of surface.

2.06 MISCELLANEOUS STAINLESS STEEL

A. Miscellaneous metal work shall be formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Holes shall be drilled or punched. Edges shall be smooth and without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitely shown or specified.

B. Connections and accessories shall be of sufficient strength to safely withstand the stresses and strains to which they will be subjected. Exposed joints shall be close fitting and jointed where least conspicuous. Threaded connections shall have the threads concealed where practical. Welded connections shall have continuous welds or intermittent welds as specified or shown. The face of welds shall be dressed flush and smooth. Provide holes for temporary field connections and for attachment of the work of other trades.

C. Miscellaneous stainless steel items shall include any miscellaneous stainless steel called for on the Drawings and not otherwise specified.

2.07 CASTINGS

A. Casting shall be of good quality, strong, tough, even-grained, smooth, free from scale, lumps, blisters, sand holes and defects of any kind which render them unfit for the service for which they are intended. Castings shall be thoroughly cleaned and will be subjected to a hammer inspection in the field by the OWNER. Matching surfaces shall be machined to a true plane surface to allow contact surfaces to seat at all points without rocking. Allowances shall be made in the patterns so that the thickness specified shall not be reduced in obtaining finished surfaces. Castings will not be acceptable if the actual weight is less than 95 percent of the theoretical weight computed from dimensions. The CONTRACTOR shall provide facilities for weighing castings in the presence of the OWNER.

B. Frames, covers, and cast grates shall be gray iron castings except as otherwise specified or indicated on the Drawings. Sizes shall be as shown on the Drawings. Covers shall have letters "RECYCLED WATER" embossed on top.

C. Frames and covers for installation in slabs shall be heavy duty, R-6013 Series as manufactured by Neenah Foundry Co., or equal.

2.08 PREFABRICATED ACCESS HATCHES

A. Prefabricated access hatches shall be a flush type mounted on a concrete slab with double leaf doors as indicated on the drawings.

B. Hatch door shall be a 1/4-in minimum aluminum checkered plate with welded stiffeners as necessary. Hatches shall have a 1/4-in galvanized channel frame with a perimeter anchor flange or strap anchors for concrete embedment around the perimeter. Hardware shall be Type 316 stainless steel.

C. Hatches shall be watertight and shall have a 1-1/2-in drainage coupling connect to the channel frame.

D. The door shall be designed to withstand H-20 wheel load.

E. Door shall open to 90 degrees and shall have a spring operator with automatic hold-open arm with release handle.

F. Provide a recessed hasp for a padlock that is covered by a hinged lid flush with the surface.

G. Access hatches shall be Type JD aluminum hatches by Bilco Company, New Haven, CT, or equal.

2.09 RECTANGULAR BAR GRATING AND APPURTENANCES.

A. As a minimum provide grating of the depths and bearing bar thicknesses noted on the Drawings, with bearing bars spaced at 1-3/16-in on center and cross bar supports at 4-in on center. Grating shall conform to the requirements of ANSI/NAAMM MBG 531 Metal Bar Grating Manual.

1. Grating cross bars shall be attached to the bearing bars with interlocked swaged joints having no exposed welding.

2. Grating provided shall meet or exceed the following load and deflection criteria for the number of spans and span lengths at which it will be utilized:

    a. The grating shall produce a deflection of 1/4-in or less under a uniform live load of 250 lbs/sq ft.

    b. Grating shall produce a deflection of 1/4-in or less under a concentrated live load of 500 lbs applied at mid-span.

3. Openings 2-in or greater in diameter/dimension and grating edges shall be banded with a bar of the same depth and thickness as the bearing bars. Cut bearing or cross bars shall be welded to the banding bar.

4. All grating perimeter edges shall be banded with a bar of the same depth and thickness as the bearing bars. Bearing bars shall be welded to the banding bar.

5. Provide supports around grating edges. Wherever practical, provide embedded angle frames with vertical dimension equal to the grating bearing bars with welded strap anchors.

B. Grating clamps, nuts, bolts, washers and other fastening devices for aluminum and stainless steel grating and grating supports shall be ASTM A167, Type 304 stainless steel.

C. Grating clamps, nuts, bolts, washers and other fastening devices for galvanized and painted grating shall be hot dip galvanized in accordance with ASTM A153.

1. Provide saddle clips grating anchors

D. Carbon Steel Grating

1. Grating material shall be in accordance with ASTM A1011 or ASTM A569. Manufacturers or distributors shall be McNichols Co.; Seidelhuber Metal Products, Inc.; Aimco-Klemp; IKG Industries; or equal.

2. Grating frames, anchors, and supports shall be steel construction.

3. Finishes

    a. Grating and frames – Galvanized in accordance with ASTM A123 after fabrication.

    b. Surface – Serrated.

E. Fabrication of Grating and Grating supports

1. Provide work true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture free from defects impairing strength or durability.

2. Field verify dimensions prior to fabrication.

3. Provide connections and accessories of sufficient strength to safely withstand stresses and strains to which they will be subjected. Threaded connections shall be made so that the

threads are concealed by fitting. Grating fasteners shall allow later removal and replacement of grating using the same fasteners.

4. Angle frames for grating and cover plates shall be welded and mitered with welded strap anchors attached.

5. Welded joints shall be rigid and continuously welded or spot welded as specified or shown. Dress the face of welds flush and smooth. Exposed joints shall be close fitting and located where least conspicuous.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install items finished except items to be embedded in concrete which shall be installed under Division 3.

B. Install items finished except items to be embedded in masonry which shall be installed under Division 4.

C. Items to be attached to concrete after such work is completed shall be installed in compliance with the details shown. Furnish to appropriate trades anchors, sockets, or fastenings required for securing work to other construction.

D. Set metal work level, true to line and plumb as indicated.

E. Field cutting of finished surfaces is not allowed unless specifically approved by the Owner. When cutting is approved, use mechanical cutting tools; do not use flame cutting tools.

F. All bolted connections shall be snug tight, unless noted otherwise.

G. Weld field connections and grind smooth where practicable. Clean and strip primed, steel items to bare metal where site welding is required. Conceal fastenings where practicable.

1. Weld only in accordance with approved WPS's which are to be available to welders and inspectors during the production process.

H. Secure metal to wood with lag screws or bolts, of adequate size, with appropriate washers and nuts.

I. Touch-up abrasions to finish or primer coatings immediately after erection and prior to both final coating and final acceptance.

J. Break contact between dissimilar metals as shown on the Drawings or as specified in Paragraph 3.01J below.

K. Field-apply coatings for installation of metal fabrications according to the following schedule. (For embedded items, coat the embed.)

1. All steel surfaces in contact with exposed concrete shall receive a protective coating of an approved heavy bitumastic troweling mastic applied in compliance with the manufacturer's instructions prior to installation.

2. Where aluminum contacts a dissimilar metal, apply a heavy brush coat of zinc-chromate primer followed by two coats of aluminum metal and masonry paint to the dissimilar metal.

3. Where aluminum contacts concrete, apply a heavy coat of zinc chromate primer to the surface of the aluminum.

4. Where aluminum contacts wood, apply two coats of aluminum metal and masonry paint to the wood.

L. Zinc coating which has been burned by welding, abraded, or otherwise damaged shall be cleaned and repaired after installation. The damage area shall be thoroughly cleaned by wire brushing and traces of welding flux and loose or cracked zinc coating removed prior to painting. The cleaned area shall be painted with two coats of zinc oxide-zinc dust paint conforming to the requirements of Military Specifications MIL-P-15145. The paint shall be properly compounded with a suitable vehicle in the ratio of one part zinc oxide to four parts zinc dust by weight.

M. Specialty products shall be installed in accordance with the manufacturer's recommendations.

N. Expansion bolts shall be checked for tightness a minimum of 24 hours after initial installation.

O. Headed anchor studs shall be welded in accordance with manufacturer's recommendations.

P. Secure grating with fastening devices as specified to prevent movement.

3.02 FIELD QUALITY CONTROL – INSPECTION

A. Notify the OWNER in writing 4 working days in advance of high strength bolting or field welding operations.

B. High strength bolting will be inspected visually. High strength bolts shall have the turned portion marked with reference to the steel being connected after the nut has been made snug and prior to final tightening. Retighten rejected bolts or remove and provide new bolts. In cases of disputed bolt installations, the bolts in question shall be checked using a calibrated wrench certified by an independent testing laboratory approved by the OWNER. The certification shall be at no additional cost to the OWNER.

C. Field welding will be inspected visually and by non-destructive testing by AWS certified welding inspectors provided by an Independent Testing Agency. This work will be paid for by the OWNER. Testing procedures will include ultrasonic testing. CONTRACTOR shall comply with requests of inspectors to correct deficiencies.

D. The fact that steel work has been accepted at the shop and mill will not prevent its final rejection at the site, before or after erection, if it is found to be defective.

E. Remove rejected steel work from the site within 10 working days after notification of rejection.

F. Grating Tolerances

1. Maximum space between adjoining or abutting sections: 1/4-in.

2. Maximum variation from top surface plane of adjoining or abutting sections or structure: 1/8-in.

3. Grating shall not “rock” or move when walked upon.

END OF SECTION

DIVISION 7

THERMAL AND MOISTURE PROTECTION

SECTION 07100

WATERPROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Waterproofing.

1.02 GENERAL REQUIREMENTS

A. This Section shall be performed in accordance with the General Conditions and Supplementary Conditions. These documents must be read with the other Contract Documents and Sections as a whole to complete the intent of the contract.

1.03 SUBMITTALS

A. Submit reports of tests of individual materials to indicate that the materials meet these specifications.

1.04 QUALITY ASSURANCE

A. Manufacturer's certification: Prior to start of installation of the work of this Section, secure a visit to the job site by a representative of the manufacturer of the waterproofing materials used, who shall inspect and shall certify:

1. That the surfaces to which waterproofing was applied were in condition suitable for that application.

2. That the materials installed complied in all respects with the requirements of this Section of these Specifications.

3. That the materials were installed in complete accordance with the manufacturer's current recommendations.

PART 2 PRODUCTS

2.01 WATERPROOFING

Wall waterproofing shall be cold-applied, seamless, elastomeric membrane and shall be one of the following:

A. Grace Construction Products:
Procor 75 spray grade membrane with Hydroduct 660 Drainage Composite Protection Course or Procor 20 trowel grade membrane with Hydroduct 660 Drainage Composite Protection Course

Contact: Paul Miller (510) 220-7745
paul.miller@grace.com

B. Sonneborn:
Hydrocide Liquid Membrane 5000 with Sonneborn Protection Course II

2.02 OTHER MATERIALS

A. Other materials, including protective covering for waterproofing, shall be only those recommended by the manufacturer of the waterproofing materials used and shall be subject to approval of the Owner.

PART 3 EXECUTION

3.01 INSTALLATION

A. Preparation: Properly and thoroughly prepare surfaces to receive waterproofing, strictly complying with the manufacturer's recommendations.

B. Installation: Install the waterproofing in strict accordance with the manufacturer's recommendations, covering surfaces where waterproofing will be required to prevent penetration of moisture through the building shell; install the required protective covering over the waterproofing to prevent damage during backfill operations.

END OF SECTION

DIVISION 9

FINISHES

SECTION 09901

SURFACE PREPARATION AND SHOP PRIME PAINTING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. The surface preparation and application of shop primers on ferrous metals, excluding stainless steels.

1.02 SUBMITTALS

A. Submit shop drawings, manufacturer's specifications and data on the proposed primers and detailed surface preparation, application procedures and dry mil thicknesses.

B. Submit representative physical samples of the proposed primers.

1.03 REFERENCE STANDARDS

A. The Society for Protective Coatings (SSPC)

1. SSPC-SP 6/NACE No. 3 - Joint Surface Preparation Standard SSPC-SP 6/NACE No. 3: Commercial Blast Cleaning

2. SSPC-SP 10/NACE No. 2 - Joint Surface Preparation Standard SSPC-SP 10/NACE No. 2: Near-White Blast Cleaning.

PART 2 PRODUCTS

2.01 MATERIALS

A. Submerged Surfaces - Shop primer for ferrous metals which will be in contact with water, either submerged or which are subject to splash action or which are specified to be considered submerged service shall be shop primed with the following:

1. Shop Prime Coat: (Zinc Micaceous Iron Oxide Polyurethane Aromatic Shop Primer)

a. TNEMEC: Series 1 Omnithane

b. Carboline: Carboguard 561

c. Sherwin-Williams Company (The): Corothane I Zinc Primer 1K Mio-Zinc.

d. PPG PMC Durathane MCZ 97-679 Series or PPG PMC Amerlock 400.

e. Or equal.

B. Non-Submerged Surfaces: Shop primer for ferrous metals which will not be in contact with water, not submerged and not subject to splash action shall be shop primed with the following:

1. Shop Prime Coat: (Zinc Micaceous Iron Oxide Polyurethane Aromatic Shop Primer)

   a. TNEMEC: Series 1 Omnithane

   b. Carboline: Carboguard 561

   c. Sherwin-Williams Company (The): Corothane I Zinc Primer 1K Mio-Zinc.

   d. PPG PMC Durathane MCZ 97-679 Series or PPG PMC Amercoat 68HS

   e. Or equal.

C. Submerged Surfaces:

1. Shop Prime Coat for Ductile Iron Pipe: (Epoxy, Polyamidoamine Shop Primer)

   a. TNEMEC: Series N140 Pota-Pox-Plus

   b. Carboline: Carboguard 561

   c. Sherwin-Williams Company (The): Macropoxy 846 NSF Winter Grade Epoxy Mill White

   d. PPG PMC Aquapon HB Potable Water Epoxy Coating 95-132 Series or PPG PMC Amerlock 2 Epoxy.

   e. Or equal.

2. Shop Prime Coat for Ferrous Metal Surfaces: (Zinc Micaceous Iron Oxide Polyurethane Aromatic Shop Primer)

   a. TNEMEC: Series 1 Omnithane

   b. Carboline: Carboguard 561

   c. Sherwin-Williams Company (The): Corothane I Zinc Primer 1K Mio-Zinc.

   d. PPG PMC Durathane MCZ 97-679 Series

   e. Or equal.

D. Non-Primed Surfaces - Gears, bearings surfaces and other similar surfaces obviously not to be painted shall be given a heavy shop coat of grease or other suitable rust-resistant coating. This coating shall be maintained as necessary to prevent corrosion during periods of storage and erection and shall be satisfactory to the OWNER up to the time of the final acceptance test.

E. Compatibility of Coating Systems - Shop priming shall be done with primers that are guaranteed by the manufacturer to be compatible with their corresponding primers and finish coats specified in Section 09902 for use in the field and which are recommended for use together.

PART 3 EXECUTION

3.01 APPLICATION

A. Surface Preparation and Priming

1. Non-submerged components scheduled for priming, as defined above, shall be blast cleaned in accordance with SSPC-SP 6/NACE No. 3, immediately prior to priming. Submerged components scheduled for priming, as defined above, shall be blast cleaned in accordance with SSPC-SP 10/NACE No. 2, immediately prior to priming. Consult manufacturer regarding required surface profiles.

2. Surfaces shall be dry and free of dust, oil, grease and other foreign material before priming.

3. Shop prime in accordance with approved manufacturer's recommendations.

B. Non-Primed Surfaces

1. Apply approved coating per manufacturer's recommendations.

3.02 FABRICATED ITEMS

A. Items to be shop primed shall be blast cleaned as specified for applicable service prior to priming. If, in the opinion of the OWNER, any prime coating that has been improperly applied or if material contrary to this Section has been used, that coating shall be removed by abrasive blasting to white metal and reprimed in accordance with this Section.

B. Shop prime coats shall be of the correct materials and applied in accordance with this Section. Remove any prime coats not in accordance with this Section by blast cleaning and apply the specified prime coat at no additional cost to the OWNER.

C. Shop primed surfaces shall be cleaned thoroughly and damaged or bare spots prepared as approved and retouched with the specified primer before the application of successive paint coats in the field.

D. Shop finish coats, if proposed and allowed, shall be equal in appearance and protection quality to a field applied finish coat. If, in the opinion of the OWNER, a shop finish coat system does not give the appearance and protection quality of other work of similar nature, prepare the surfaces and apply the coat or coats of paint as directed by the OWNER to accomplish the desired appearance and protection quality. Submit to the OWNER substantial evidence that the standard finish is compatible with the specified finish coat.

E. Properly protect the shop prime and finish coats against damage from weather or any other cause.

F. Wherever fabricated equipment is required to be blast cleaned, protect motors, drives, bearings, gears, and similar equipment, from the entry of grit. Equipment found to contain grit shall be promptly and thoroughly cleaned.

END OF SECTION

DIVISION 13

SPECIAL CONSTRUCTION

SECTION 13110

CATHODIC PROTECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Design, installation and testing of cathodic protection systems and test stations.

1.02 RELATED WORK

A. Ductile iron pipe and fittings are included in Section 02616.

B. Valves and appurtenances are included in Section 02640.

C. Steel Casing Pipe is included in Section 02322.

1.03 SUBMITTALS

A. Submit the following:

1. Qualifications for Corrosion Specialist as specified in Paragraph 1.05A herein. Include a brief description and dates for each project, with names and telephone numbers of contact persons at OWNERs of installations on which testing was performed. Also include a copy of the Corrosion Specialist's NACE certificate.

2. Product data including manufacturer's descriptive and technical literature, catalog cuts and installation instructions for each cathodic protection item.

3. Shop drawings prepared by the Corrosion Specialist including:

   a. A listing of the piping and structures to be cathodically protected.

   b. Calculations used to determine the size and frequency of placement of sacrificial anodes.

   c. Shop drawings showing the locations and sizes of anodes, test facilities and other cathodic protection materials installed for each cathodic protection system.

4. A narrative description of the proposed testing procedures, including test schematics, physical constants and equations, and sample data sheets for each of the tests specified in Paragraph 3.02.

5. A complete list of instruments to be used for system testing, including the instrument manufacturer's name, model number, serial number and calibration documentation showing that each instrument was calibrated by an independent agency within 12 months of the proposed testing date.

6. Test reports, including field data sheets for each completed cathodic protection system within 21 days after completion of testing each system.

7. As-built drawings showing the location of each anode, test station lead wire attachment point and test station housing with respect to at least two permanent reference points.

8. An Installation, Operation and Maintenance Manual combining all of the cathodic protection systems. The manual shall include manufacturer's data, installation instructions and operating instructions for each component of the systems; results of functional tests; and recommended procedures and frequency for maintenance and periodic testing.

1.04 REFERENCE STANDARDS

A. National Association of Corrosion Engineers (NACE)

1. NACE RP01-69 - Control of External Corrosion on Underground or Submerged Metallic Piping Systems.

2. NACE RP02-86 - Electrical Isolation of Cathodically Protected Pipelines.

3. NACE RP-01-87 - Discontinuity (Holiday) Testing of Protective Coatings.

4. NACE RP-02-74 - High Voltage Electrical Inspection of Pipeline Coatings Prior to Installation.

B. American Water Works Association (AWWA)

1. AWWA C209 - Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.

2. AWWA C214 - Tape Coating Systems for the Exterior of Steel Water Pipelines.

3. AWWA C216 - Heat-Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Special Sections, Connections and Fittings for Steel Water Pipelines.

C. National Electrical Code (NEC)

D. American National Standards Institute (ANSI)

1. ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.

1.05 QUALITY ASSURANCE

A. Installation and Testing

1. CONTRACTOR shall employ an individual or firm as his Corrosion Specialist to design and supervise the installation of and test cathodic protection systems. The Corrosion Specialist shall have at least five years of successful experience within the last five years in work of comparable type and quality to the work specified in this Section. Work designated as being performed by the Corrosion Specialist shall be performed under the supervision of a National Association of Corrosion Engineers (NACE) certified Corrosion Specialist or Cathodic Protection Specialist. Testing shall be performed by personnel representing the

Corrosion Specialist having at least three years of employment testing cathodic protection systems within the last 5 years.

B. Corrosion Control and Cathodic Protection Products and Equipment

1. Use products and equipment that duplicate products and equipment which has been in satisfactory use for a minimum period of 5 years within the last 5 years.

2. Use new products and equipment.

3. Products and equipment shall be obtained from firms regularly engaged in the manufacture and distribution of the products and equipment specified in this Section.

1.06 SYSTEM DESCRIPTION

A. Furnish, install and test cathodic protection systems and test stations for underground, ductile iron pipe and fittings, valves, and restraint harnesses as specified herein and as shown on the Drawings.

1. Provide cathodic protection systems for new buried recycled water lines.

2. Provide test stations at insulating devices.

3. Provide in-line test stations for cathodic protection systems and at locations indicated.

4. Test cathodic protection systems, electrical continuity of piping, and the electrical effectiveness of insulating devices and of sacrificial anodes, as specified.

1.07 DELIVERY, STORAGE AND HANDLING

A. Package and ship materials in clearly marked containers.

B. Accept materials which are not visibly damaged, which bear the correct manufacturer's identification and certification, and which conform to the proper styles and dimensions specified in this Section.

C. Store materials on pallets, dry and in original packing.

D. Store liquid materials to avoid freezing and combustion.

E. Protect materials from weather and physical damage.

1.08 SEQUENCING AND SCHEDULING

A. Schedule the cathodic protection system installation concurrent with the pipe installation and coordinate the test schedules prior to backfilling, after backfilling and prior to the connection of the piping system into other structures.

1.09 REFERENCED DOCUMENTS

A. Geotechnical Report: "Geotechnical Data Report, Napa-Sonoma Salt Marsh Restoration Pipeline, Napa and Sonoma Counties, CA", Blackburn Consulting, April 28, 2011.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Cathodic protection materials shall be supplied by:

1. BMS Division of Ablestar Corporation, Stoughton, MA (508) 559-2788.

2. Harco Technologies, Auburn, NH (603) 644-0882.

3. Stuart Steel Protection Corporation, South Bound Brook, NJ (908) 469-5544.

4. Or equal.

B. Thermite weld covers shall be supplied by:

1. Royston Handy Cap 2.

2. Canusa Type CPK Protection Kit.

3. Phillips Poly Kap.

4. Or equal.

2.02 MATERIALS

A. Dielectric Insulating Materials

1. Flange Insulating Kits: Provide dielectrically insulated flanged joints in accordance with ANSI B16.1 using flange insulating kits. Flange insulating kits shall include gasket, sealing element, bolt sleeves, double insulating washers and mechanical washers. Kits shall be provided in complete sets from a single manufacturer, securely packaged and clearly labeled as to size, ANSI rating, style and material with the following provisions:

a. For pipe up to 36-in in diameter:

1) Gasket: Type E, full-faced, 1/8-in thick nitryl faced phenolic gasket with a rectangular cross sectional O-ring seal.

2) Bolt Sleeves: Full length, 1/32-in thick, phenolic.

3) Insulating Washers: 1/8-in thick, phenolic.

4) Mechanical Washers: 1/8-in thick, carbon steel.

B. Wire and Wire Attachments

1. Test Wires: Provide AWG #8 seven-strand copper wire with HMWPE insulation, suitable for underground service.

2. Joint Bond Wires: Provide AWG #4 seven-strand copper wire with HMWPE insulation, suitable for underground service.

3. Thermite Welding Materials: Provide molds and thermite welding cartridges suitable for welding test wires to pipes and anode lead wires to anode header cables.

4. Thermite Weld Covers: Provide molded plastic weld caps complete with primer and filler as recommended by manufacturer.

C. Magnesium Anodes

1. Prepackaged Anodes

a. Provide prepackaged, high potential magnesium anodes. Anodes shall consist of a core, ingot, lead wire with an encapsulated connection to the core, backfill, and a permeable cloth bag. Additional requirements are:

1) The core shall be perforated, galvanized steel.

2) The ingot shall be nominally 2-in square and 60-in long with a nominal weight of 20 lbs.

3) The ingot composition shall have the following:

Element	Percent by Weight
Aluminum	0.01, max.
Manganese	0.5 to 1.3
Zinc	0.05, max.
Copper	0.02, max.
Iron	0.03, max.
Nickel	0.001, max.
Other Metallic Elements	0.05 each or 0.3 max. total
Magnesium	Remainder

4) Lead wires shall be single conductor AWG #12 copper wire with 600 Volt THW or TW insulation. The lead wire shall be silver soldered or brazed to the core and connection shall be encapsulated with cast epoxy. Lead wires shall be 10-ft long.

5) The ingot shall be prepackaged in a permeable cloth sack containing backfill with the following composition:

Material	Percent by Weight
Hydrated Gypsum	75
Bentonite	20

Sodium Sulfate 5

6) The nominal packaged weight shall be 70 lbs for the 20-lb ingot.

2. For restrained insulating couplings provide the following:

a. Bolt Sleeves: 1/32-in thick, cut to size, phenolic.

b. Double Insulating Washers: 1/8-in thick, phenolic.

c. Double Mechanical Washers: 1/8-in thick, carbon steel.

D. Test Station Housings and Appurtenances

1. Test Station Housing: Provide test station housings complete with terminal boards and hardware with the following requirements:

a. Housing: Corrosion resistant with watertight and non-locking cover marked "RECYCLED WATER CP", suitable for flush mounting.

b. Terminal Board: Polymeric board, sized to fit into and permanently mounted inside housing. Terminals consisting of corrosion resistant bolts, washers and locking nuts. Number of terminals to suit specific test function.

c. Bonding Straps: Corrosion resistant metal straps, sized to fit between terminals.

2. Permanent Reference Cell: Provide prepackaged, permanent, underground, copper-copper sulfate reference cells. Permanent reference cells shall consist of a copper-copper sulfate half cell constructed in a 2-in diameter by 8-in long Schedule 80 PVC tube; a 50-ft AWG #14 lead wire with HMWPE insulation; special backfill as recommended by the manufacturer; and a permeable cloth bag. The nominal dimensions of the packaged assembly shall be 8-in diameter by 16-in long, with a nominal weight of 15 lbs. The electrical stability shall be plus/minus 5 millivolts with a 3 microampere load. The design life shall be not less than 10 years.

3. Test Electrode: Provide test electrodes consisting of 50-ft of AWG #12 stranded copper wire with THWN insulation brazed to a 12-in long piece of #6 steel reinforcing bar. The brazed connection and any bare wire shall be thoroughly coated with bitumastic.

E. Liquid Coatings

1. Bitumastic: Provide fast drying (not longer than 2 hours at 70 degrees F) cold applied, thixotropic mastic bitumen consisting of bituminous resins, synthetic elastomers, additives and fillers within an aromatic solvent system, applied in two coats to a total of 20 mils dry film thickness. Minimum volume resistivity shall be 10^{12} ohm-centimeters. Use primer as recommended by manufacturer. The use of asphalt roofing products shall not be permitted.

F. General Items

1. Brass Tags: 1-in diameter, permanent.

2. Nonmetallic strapping or tape.

3. Cable Marking Tape: Yellow, minimum 2-in wide, marked "WARNING: CATHODIC PROTECTION CABLE BELOW."

4. PVC Pipe and Bushings: Schedule 80, diameter to suit application.

5. Pipeline Felt: 15-lb, glass reinforced, asphalt impregnated. Width to suit application.

G. Heat Shrinkable Sleeves: Provide in accordance with AWWA C216 (Type I or II), complete with filler material as required. Provide two days of field technical assistance by the manufacturer's representative.

H. Protective Wrapping for Buried Metallic Items: The wax tape protective wrapping for flanged joints, flexible or mechanical couplings, flanged coupling adapters, valves, special areas and other exposed appurtenances and joints below final grade shall be protected by a primer, mastic, wrapping, and overwrapping system, Denso, Trenton, or equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Exothermic Welding: Connections between copper conductors and the pipe shall be made with exothermically welded connections as indicated. Connections shall be made conforming to the manufacturer's recommended procedures, materials and equipment, with the following additional requirements:

1. Do not allow the hot mold or welding debris to contact coated pipe.

2. Remove slag from the mold after each weld. Clean the mold and cover after every 6 to 10 welds.

3. Remove the slag from the weld after it has cooled. Test welds by striking at a 45 degree angle with a two pound hammer while pulling on the wire.

4. Cover the entire area of test station wire welds with a weld cover in accordance with the manufacturer's instructions. Coat wire splices with a splice insulation kit in accordance with the manufacturer's instructions; use of splice kits after their expiration date will not be permitted.

5. Welds or bond wires across pipe joints which will be covered with heat shrinkable sleeve shall not be coated.

B. Electrical Bonding: Electrically bond joints on new ductile iron piping which are not welded, except those indicated to be electrical insulators.

C. Insulated Flanges and Couplings - Install flange insulating kits and insulated couplings at the locations indicated, complete with test stations as indicated. Install flange insulating kits in accordance with the manufacturer's instructions.

D. Joint Coating: Apply heat-shrinkable sleeve to underground joints on cathodically protected pipe after bonding, but before installation of external restraints such as clamps and tie rods, in accordance with the manufacturer's instructions and the following:

1. Dress bond wires neatly to follow the contours of the joint so as to provide as smooth a surface as possible.

2. Install filler material at sharp bends and other protrusions to establish a smooth contour and eliminate air pockets beneath the heat-shrinkable sleeve.

3. Roughen the tape coating that will be under the sleeve with coarse sandpaper.

4. Allow 30 minutes, minimum, before backfilling sleeved joints.

5. The CONTRACTOR shall remove and replace any sleeve if installation results in the presence of air pockets, wrinkles or is otherwise unsatisfactory.

6. Field applied tape coating conforming to the material requirements of Paragraph 2.02E3 above may be used as an alternative to heat shrinkable sleeves for welded pipe joints. Apply tape coating according to manufacturers' instructions, complete with primer.

E. Bitumastic Coating: Thoroughly cover bare metal surfaces such as tie-rods, clamps and anchor plates with bitumastic. Prior to coating, remove residual films with suitable solvents and remove adherent debris and rust with a wire brush. Apply bitumastic in accordance with the manufacturer's instructions using two coats to achieve a final dry film thickness of 20 mils. Allow bitumastic to dry completely before backfilling. The use of roofing tar, or similar, products will not be permitted.

F. Anodes: Install magnesium anode ground beds for piping, as indicated, within 10-ft of the locations indicated, complete with test stations.

1. Horizontally install two anodes every 10-ft along the steel pipe segments such that the side of the anode is at the invert of the pipe and 5-ft away from the side of the pipe. Anode spacing can be adjusted for obstructions; minimum spacing shall be 10-ft. Do not use the lead wire to lift the anode.

2. Splice individual anode lead wires to a common header cable as indicated and terminate the header cable at the test box.

3. Wet packaged anodes thoroughly with potable water before backfilling the hole. Backfill with native soil, free of stones, bricks or other debris for backfilling. Wet the backfill to aid compaction around the anode. The use of select fill or sand for backfilling shall not be permitted.

G. Test Stations: Install test stations at insulating devices and the locations indicated. Install inline test stations at locations indicated. Install one in-line test station for every 100 feet of electrically continuous cathodically protected new steel, ductile iron, or PCCP main. Each test station shall include the required test wires, permanent reference cells, test electrodes and test box as indicated. Below grade test station wiring shall be protected in PVC conduit. Below grade test station wiring shall be marked over its fully length with cable marking tape. Test leads shall be

permanently identified inside the test station housing, using brass tags. The following requirements shall also apply:

1. Install test wires, anodes, test electrodes and permanent reference cells as indicated.

2. Install permanent reference cells in accordance with manufacturer's instructions.

3. Where test boxes will be offset from pipes by more than 5-ft, test wires shall be protected in a Schedule 80 PVC conduit as indicated.

4. At-grade test boxes shall be field located as closely as possible to the positions indicated. They shall be placed in accessible locations. The CONTRACTOR shall provide as-built drawings with detailed, proposed locations for each at-grade test box.

5. Test boxes in unpaved locations shall be set in a concrete pad.

6. A minimum of 18-in of slack shall be maintained in wires beyond the top of the test box. Each wire shall be identified as indicated. Slack wire shall be neatly coiled and tucked in the test box. No connections shall be made. If insulation is stripped at the free ends, it shall be taped to avoid electrical contact.

H. Protective Wrapping: Apply protective wrapping to all exposed metal appurtenances and joints below final grade in accordance with the manufacturer’s written instructions. Apply primer to all surfaces. Fill void areas with mastic to produce a uniform surface for subsequent tape wrapping.

3.02 TESTING

A. General: The CONTRACTOR's Corrosion Specialist shall conduct the electrical tests and inspections specified for:

1. Test station wires

2. Electrical continuity

3. Insulating devices

4. Magnesium anodes

5. Protective coatings.

B. Test Procedures: Prior to pipe installation, the CONTRACTOR shall submit detailed test procedures for each test specified below. Procedures shall include test schematics, sample data sheets, equations for calculations, proposed test equipment and an outline narrative of each test. A minimum of three test readings shall be taken to determine an electrical constant or property. Additional measurements shall be taken until removal of the highest or lowest value alters the average of the measurements by less than 5 percent. The OWNER shall observe the approved initial field tests. Should the techniques appear valid after two separate tests, final approval will be forwarded to the CONTRACTOR by the OWNER. Following such approval, the testing techniques shall not be varied or changed without approval from the OWNER.

C. Equipment: The CONTRACTOR shall submit a list of test instruments to be used for the electrical testing. The list shall include the manufacturer's name, model number, and calibration

certificate for each instrument. The calibration certificate shall show that each instrument was calibrated by an independent agency within one year of use for this work. Test instrument requirements are as follows:

1. Voltmeter, D.C.: Center zero, analog, minimum input impedance of 50,000 ohms/volt, accurate to within 2 percent full scale. Full scale response time shall be no more than 0.5 second. Full scale ranges: 0 to 10 mV; 0 to 100 mV; 0 to 1 V; 0 to 10 V; 0 to 100 V.

2. Ammeter, D.C.: Maximum shunt voltage drop of 20 mV, accurate to within 2 percent full scale. Full scale ranges: 0 to 1 A; 0 to 10 A; 0 to 100 A. (D.C. voltmeter and ammeter may be combined in a single unit.)

3. Milliammeter, D.C.: Maximum shunt voltage drop of 20 mV, accurate to within 2 percent full scale. Full scale ranges: 0 to 10 mA; 0 to 100 mA. (D.C. ammeter and milliammeter may be combined in a single unit.)

4. Shunts: May be used as an alternative to milliammeter and ammeter. Meter and shunt combination alternatives shall be accurate to within 2 percent full scale, covering full scale range requirements for milliammeter and ammeter.

5. Insulated Flange Tester

6. Power Source, D.C.: 6 Volt or 12 Volt automotive wet cell battery.

7. Test Wires: Single conductor cable, stranded copper, sized AWG #12 and AWG #18 with a minimum 600 Volt neoprene or EPDM insulation in perfect condition. Sufficient lengths to establish test circuits with appropriate terminal lugs and clamp or clip terminations.

8. Reference Electrodes: Saturated copper-copper sulfate reference half-cell with a length of 5-in, a diameter of 1-3/8-in or 3-in, and a porous ceramic plug.

9. Electrical Contact Locator

10. Soil Resistivity Tester: A single rod soil resistivity apparatus; and a soil resistance meter.

11. High Voltage Holiday Tester: Pulse-type detector and exploring electrode(s) meeting test voltage requirements of NACE RP-02-74 and NACE RP-01-87.

D. Documentation: The CONTRACTOR shall submit data sheets and calculations to the OWNER for each test for review and approval. Individual inspection and test reports shall be submitted to the OWNER within 7 days of testing. A final test and inspection report shall be submitted within 30 days of the completion of individual component tests. A cathodic protection system verification report shall be submitted within 60 days of completion of the individual component tests.

E. Physical Inspection: During installation and prior to backfilling the following items shall be tested or inspected by the CONTRACTOR as indicated:

1. Each thermite weld to piping shall be tested by striking the weld at a 45 degree angle with a 2-lb hammer while pulling firmly on the wire. Defective welds shall be replaced at no additional cost to the OWNER.

2. The areas of pipe, weldment and bare wire exposed around exothermic welds shall be inspected to assure that metal is fully covered by heat-shrinkable sleeves or weld covers.

3. Pipe coatings shall be visually inspected to assure freedom from damage and defects. Subsequent to visual inspection, electrical holiday testing shall be conducted as specified for the specific coating in NACE RP-02-74 and RP-01-87. Heat shrink sleeves and tape coated joints shall also be holiday tested. Holiday tests shall be witnessed by the OWNER. Coating flaws shall be repaired and retested.

4. Insulating devices shall be inspected to assure that material specifications are satisfied. Thickness of insulating components shall conform to specifications. A visual inspection of the assembled and installed devices shall be conducted to assure that the components suffer no damage during installation.

F. Test Station Wire Effectiveness: Electrical measurements will be made on each test lead in each completed test station. Measurements shall include:

1. Measure the electrical resistance of pairs of test wires attached to the structures at each test station facility using separate current and voltage circuits.

2. Calculate the theoretical resistance of the test wires, including the resistance of the structure between them.

3. The test wires shall be considered effective if the measured resistance is less than or equal to 120 percent of the theoretical resistance. Failure to meet this criterion shall be reported to the OWNER. Corrective action shall be taken at no additional cost to the OWNER.

4. Measure the native ground voltages of the structure, test coupons, anodes, and permanent reference cell with respect to a saturated copper-copper sulfate reference electrode placed in the bottom of the appropriate test station enclosure.

G. Pipe Continuity: The electrical continuity of bonded pipe shall be tested after backfilling. Tests shall be conducted on complete, isolated segments. Access to the pipe shall be obtained through test station facilities. Tests shall be conducted as follows:

1. Measure the longitudinal (series) resistance of the bonded pipe using separate current and voltage circuits established between individual structure test wires at each test station.

2. Calculate the theoretical longitudinal resistance of the reach of pipe including the resistance of bond wires.

3. Pipe continuity shall be considered effective if the measured longitudinal resistance is less than or equal to 110 percent of the theoretical longitudinal resistance. Failure to meet this criterion shall be reported to the OWNER. Corrective action shall be taken at no additional cost to the OWNER.

H. Insulated Joints: Insulated joints shall be tested to assure electrical separation between buried metallic piping. Tests shall be conducted prior to backfilling. Measure the resistance across the device with an insulation checker. The insulating device shall be considered effective if so

indicated by the test instrument. The OWNER shall be notified if this criterion is not satisfied. Corrective action shall be taken at no additional cost to the OWNER.

I. Magnesium Anode Effectiveness: The effectiveness of the anodes at each test station shall be tested after the anodes are backfilled. Access to the anodes shall be through anode wires in the test stations. Separate current and voltage circuits shall be established between the anodes and a suitable earth ground. Tests shall be conducted as follows:

1. Measure the resistance-to-earth of the anode ground bed.

2. Calculate the theoretical resistance-to-earth of the anode ground bed, using data for soil resistivity provided per the geotechnical report as summarized below.

Bore Hole:	Resistivity: (ohm-cm)
B2	1170
B4	1860
B5	1070
B7	260
B11	1170
B17	1040
B21	820
B29	500
B34	1170
B37	674

3. The anode ground bed shall be considered acceptable if the measured ground bed resistance is less than or equal to 150 percent of the theoretical ground bed resistance. Failure to satisfy this criterion shall be reported to the OWNER. At the OWNER's discretion, the following may be required:

   a. If the theoretical ground bed resistivity does not fall within the criterion set forth in Paragraph 3.02I.3 above, then the CONTRACTOR shall measure resistivity of the soil near each ground bed. This data shall be used to recalculate the theoretical ground bed resistance.

   b. If the new calculated theoretical ground bed resistivity does not meet the criterion as set in Paragraph 3.03I.3 above, then the CONTRACTOR shall, at no additional cost to the OWNER, excavate one of the anodes for physical examination. This examination shall include evaluation of the soil environment around the anode and the electrical splice to the anode. An additional two anodes shall be excavated if conditions observed at the first anode indicate material or installation problems.

END OF SECTION

SECTION 13111

CORROSION MONITORING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. The installation of the corrosion monitoring system components. Provide the following work as shown on the Drawings:

1. Installation of test stations as shown on the Drawings.

2. Electrical bonding of buried non-welded joint steel piping.

3. Electrical bonding across valves, sleeve couplings, and flanges on buried steel water piping.

4. Bonding on iron joints as shown on the Drawings.

1.02 RELATED WORK

A. Steel Casing Pipe is included in Section 02322.

B. Ductile iron fittings are included in Section 02616.

C. Cathodic protection is specified in Section 13110.

1.03 SUBMITTALS

A. Submit the following:

1. A complete list of equipment and materials, including name and manufacturer, catalog number, size, finish, and any other pertinent data necessary for proper identification and to establish conformance with this Section.

2. Certification by the wire manufacturer covering conformance of wire insulation to designated specifications.

3. Provide proof of NACE Certification for corrosion specialist.

1.04 REFERENCED STANDARDS

A. National Electrical Manufacturers Association (NEMA)

B. American Society for Testing and Materials (ASTM)

C. Institute of Electrical and Electronic Engineers (IEEE)

D. American National Standard Institute (ANSI)

E. Insulated Power Cable Engineers Association (IPCEA)

F. Occupational Safety and Health Administration (OSHA)

G. National Association of Corrosion Engineers (NACE)

H. Electrical equipment and materials; and the design, construction, and installation thereof shall comply with applicable provisions of the National Electric Code (NEC) and applicable local codes and regulations.

1.05 QUALITY ASSURANCE

A. Work under this Section shall be completed by a corrosion specialist who is NACE certified with a minimum of 5 years of experience in corrosion monitoring and cathodic protection construction.

1.06 INTERFERENCE AND ERRONEOUS LOCATIONS

A. The locations of corrosion monitoring equipment and appurtenances as shown on the Drawings are approximate only. Exact locations shall be determined by the CONTRACTOR subject to the approval of the OWNER.

PART 2 PRODUCTS

2.01 BONDING CABLES AND LEAD WIRES

A. Bonding cables and test lead wires shall be of the size shown on the Drawings and insulated with material designated for direct burial. Extreme care must be taken to ensure that cables and test leads are free from nicks, cuts, punctures, and abrasions. Any damage to insulation must be brought to the attention of the OWNER and will require cable or test lead replacement.

2.02 WIRE IDENTIFICATION

A. Wire shall be identified using nylon wire markers as shown below. The letters and numbers shall be printed.

1. 6 Digit Cable Identification Label

2. Digits 1 and 2: Pipe Diameter in Inches

3. Digit 3: Pipe Material (use letters below)

C	Cast Iron
S	Steel
R	Reinforced Concrete
K	Copper
W	Wrought Iron
G	Galvanized
H	Riveted Steel
B	Brass

4. Digit 4: Pipe Lining (use letters below)

5. Digit 5: Pipe Coating (use letters below)

C	Cement Mortar
B	Coal Tar
M	Asphalt Mastic
U	Unlined
W	Dipped and Wrapped
E	Epoxy
P	Plastic
A	Aggregate

6. Digit 6: Station

H	High Station Cable
L	Low Station Cable

2.03 EXOTHERMIC WELDS

A. Exothermic welds shall be provided for cable to structure connections in strict accordance with the manufacturer's recommendations and as shown on the Drawings. Exothermic welds shall be Cadweld by Erico Products, Inc.; Thermoweld by Continental Industries, Inc., or equal. Duxseal packing shall be Manville or equal, and used where necessary to prevent leakage of molten weld metal.

B. The shape and charge of the exothermic weld shall be chosen based on the following parameters:

1. Pipe material (Carbon Steel or Cast Iron).

2. Pipe size.

3. Wire material.

4. Number of strands to be welded.

5. Orientation of weld (vertical or horizontal).

C. Type of exothermic weld to be used shall be submitted to the OWNER for approval.

2.04 BITUMASTIC COATING

A. Bitumastic coating shall be TC Mastic by Tapecoat Company; Bitumastic 505 by Koppers Company, Inc., or equal.

2.05 WELD CAPS

A. Weld caps shall be Royston Handy Cap by Royston Laboratories, Inc.; Thermit Weld Cap by Phillips Petroleum Co., or equal.

2.06 TAPE

A. Tape for wrapping steel pipe and conduit shall be high strength, corrosion resistant polyvinyl tape, with a minimum thickness of 10 mils. Tape shall be continuously printed with the manufacturer's name and mil thickness. Tape shall be Calpico V1-10 or equal.

2.07 WARNING TAPE

A. Warning tape to be placed above cables and anodes shall be manufactured by Farwest Corrosion Inc. The tape shall clearly state “Caution Cathodic Protection Cable Buried Below”. The tape shall be 6” in width.

PART 3 EXECUTION

3.01 EXCAVATION AND BACKFILL

A. Backfill and bedding shall be free of broken pavement, rocks, and any objects which would damage wires, insulation, coatings, or other underground appurtenances.

3.02 FOREIGN STRUCTURE INTERFERENCE

A. Electrical contact of metallic pipe and/or fittings installed under this Work with other foreign grounded metallic structures shall be prevented at the time of the installation.

3.03 WIRE IDENTIFICATION

A. Wire identifiers shall be placed on the wires prior to the backfill.

3.04 EXOTHERMIC WELDS

A. Exothermic weld connections shall be installed as shown on the Drawings. Coating materials shall be removed from the surface over an area just sufficient to make the connection. The steel surface shall be cleaned to white metal by grinding or filing prior to welding the conductor. Resin impregnated grinding wheels will not be allowed.

B. No connections to the structures or piping shall be buried until the OWNER has inspected the connections and given permission to backfill. Connections made in violation of this provision shall be rejected, removed, and replaced.

C. Exothermic welds shall be tested by the CONTRACTOR for adherence to the pipe and for electrical continuity between the pipe and wires. Defective welds shall be removed and replaced. A 22-ounce hammer shall be used for testing adherence by striking a blow to the weld. Care shall be taken to avoid hitting the wires.

3.05 REPAIR OF EXOTHERMIC WELD AREAS

A. Pipeline coatings which are damaged by exothermic welding and other corrosion monitoring system construction work shall be repaired prior to backfilling the pipeline. Welding slag shall be removed, and surfaces to be coated shall be cleaned prior to the application of coating materials.

B. A coating shall be applied to exothermic weld locations. The coating shall be a bitumastic coating as listed in this Section. The coating shall be covered with a plastic weld cap. Surfaces must be clean, dry and free of oil, dirt, loose particles, and other foreign materials prior to application of the coating.

C. Where the existing pipeline coating is coal tar, a mastic coating shall be brushed onto exposed or damaged areas to obtain a continuous mastic coating.

D. Where the existing pipeline coating system is cement mortar, non-shrinking grout as specified in Section 03600 shall be used to restore a continuous cement mortar coating.

3.06 BONDING CABLES AND TEST LEAD WIRES

A. Steel piping with non-welded joints shall be joined with two No. 4 AWG bonding cables across each joint. Each buried valve in a steel pipeline shall be bonded to each side of the adjoining steel pipeline with two No. 4 AWG bonding cables (a total of four per valve).

B. Buried sleeve couplings shall be bonded to the adjoining pipeline and across the coupling components as shown on the Drawings.

C. Wires buried in the ground shall be laid straight, without kinks and shall have a minimum cover of 24-in. The bottom of the finished trench shall be free from stones, roots, or other materials which might damage the wire during or after installation.

D. Each wire run shall be continuous in length and free of joints or splices, unless otherwise specified or shown on the plans. Care shall be taken during installation to avoid punctures, cuts, or other damage to the wire insulation. Damage to insulation will require replacement of the entire length of wire.

E. Slack in each wire shall be sufficient to allow removal of wire extension for testing and shall be as shown on the Drawings.

F. Where buried cable is to be placed in existing conduit, the conduit diameter must be of sufficient diameter to accommodate the additional cable. This shall be determined by the number and size of both existing and new cable in accordance with applicable codes and standards. This shall also apply where new cable is to be installed in new PVC conduit. PVC conduit shall be installed to a minimum depth of 24-in below grade.

G. Warning tape shall be installed above buried conduits to a maximum depth of 18-in below grade.

3.07 TEST STATIONS

A. Install test stations as located on and as shown on the Drawings. Verify final location of the test stations. Wire identifiers shall be placed on wires prior to backfill and installation of test stations.

3.08 TESTING

A. Upon completion of installation of components as shown on the Drawings and in accordance with this Section, testing shall be performed by the CONTRACTOR in the presence of the OWNER representative to demonstrate that the installation has been completed and is in working order in conformance with the Drawings and this Section. Joint bonds and test leads shall be

tested prior to backfilling. Dielectric insulating flanges shall be tested after assembly and before backfill to ensure the flanges are electrically isolated.

B. The test data shall be submitted to the OWNER for acceptance to demonstrate that the system is in proper working order. The cost of the testing shall be borne by the CONTRACTOR, including any additional expenses which result from retesting due to equipment or installation which is not in conformance with this Section.

END OF SECTION

DIVISION 15

MECHANICAL

SECTION 15101

VALVE ACTUATORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Installation of actuators on valves in vaults, complete and ready for testing and operation.

1.02 RELATED WORK

A. Electrical work is included in Division 16020.

B. Valves and appurtenances are included in Division 2.

1.03 SUBMITTALS

A. Submittals shall include at least the following:

1. Valve tag number.
2. The manufacturer and supplier.
3. The address at which equipment will be fabricated or assembled.
4. Drawings showing assembly details, materials of construction and dimensions.
5. Descriptive literature, bulletins and/or catalogs of the equipment.
6. The total weight of each item.
7. A complete bill of materials.
8. Additional submittal data, where noted with individual pieces of equipment.
9. Individual electrical control schematics and wiring diagrams for each valve operator with external interfaces, identified exactly as detailed on the Electrical and Instrumentation Drawings. Standard catalogue cut sheets that show typical wiring diagrams only are not acceptable. Valve actuators shall be coordinated with electrical requirements shown on the Drawings and valves as specified herein.

B. Test Reports

1. Provide certified hydrostatic test data, per manufacturer's standard procedure or MSS-SP-61 for valves in accordance with the specific valve sections in Division 2.

C. Certificates

1. For each valve specified to be manufactured, tested and/or installed in accordance with AWWA and other standards, submit an affidavit of compliance with the appropriate standards, including certified results of required tests and certification of proper installation.

D. Manufacturer's Installation and Application Data

E. Operating and Maintenance Data

1. Operating and maintenance instructions shall be furnished to the Owner. The instructions shall be prepared specifically for this installation and shall include required cuts, drawings, equipment lists, descriptions and other information required to instruct operating and maintenance personnel unfamiliar with such equipment.

1.04 REFERENCE STANDARDS

A. ASTM International

1. ASTM A48 - Standard Specification for Gray Iron Castings.

2. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.

3. ASTM A240 - Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels.

4. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes.

5. ASTM A436 - Standard Specification for Austenitic Gray Iron Castings.

6. ASTM A536 - Standard Specification for Ductile Iron Castings.

7. ASTM B30 - Standard Specification for Copper-Base Alloys in Ingot Form.

8. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings

B. American Water Works Association (AWWA)

1. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

2. AWWA C500 - Metal-Seated Gate Valves Supply Service

3. AWWA C504 - Rubber-Seated Butterfly Valves

4. AWWA C507 - Ball Valves, 6-in through 48-in (150mm through 1200mm)

5. AWWA C508 - Swing-Check Valves for Waterworks Service, 2-in (50mm through 24-in (600mm) NPS

6. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service

7. AWWA C511 - Reduced-Pressure Principle Backflow-Prevention Assembly

8. AWWA C540 - Power-Actuating Devices for Valves and Sluice Gates

9. AWWA C550 - Protective Epoxy Interior Coatings for Valves and Hydrants

10. AWWA C800 - Underground Service Line Valves and Fittings

C. American National Standards Institute (ANSI)

1. ANSI B1.20.1 - Specifications, Dimensions, Gauging for Taper and Straight Pipe Threads (except dry seals).

2. ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings

3. ANSI B16.10 - Face-to-Face and End-to-End Dimensions of Valves

4. ANSI B16.104 - Butterfly Valves

D. American Iron and Steel Institute (AISI)

E. Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS)

1. MSS-SP-61 - Pressure Testing of Steel Valves.

2. MSS-SP-67 - Butterfly Valves.

3. MSS-SP-70 - Cast Iron Gate Valves, Flanged and Threaded Ends.

4. MSS-SP-71 - Cast Iron Swing Check Valves, Flanges and Threaded Ends.

5. MSS-SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Services.

6. MSS-SP-78 - Cast Iron Plug Valves, Flanged and Threaded Ends.

7. MSS-SP-80 - Bronze Gate, Globe, Angle and Check Valves.

8. MSS-SP-82 - Valve Pressure Testing Methods

9. MSS-SP-98 - Protective Coatings for the Interior of Valves, Hydrants and Fittings.

F. National Electrical Manufacturers Association (NEMA)

G. Underwriters Laboratories (UL)

H. Factory Mutual (FM)

1.05 QUALITY ASSURANCE

A. Qualifications

1. Valves and appurtenances shall be products of well established firms who are fully experienced, minimum 5 years, reputable and qualified in the manufacture of the particular equipment to be furnished.

2. Units of the same type shall be the product of one manufacturer.

3. Motor actuators shall be 480 volt and shall be the product of one manufacturer. This requirement shall be coordinated with vendors who supply actuated valves as part of systems specified.

B. Certifications

1. The manufacturers shall furnish an affidavit of compliance with Standards referred to herein as specified in Paragraph 1.03C above. Refer to PART 3 for testing required for certain items in addition to that required by referenced standards.

C. Provide the services of a qualified and factory-trained service representative of the manufacturer to provide operational and maintenance instruction, for a 1 day, 8 hour period for each type of the following equipment:

1. Valve motor operators.

D. Inspection of the units may also be made by the Owner after delivery. The equipment shall be subject to rejection at any time due to failure to meet any of the specified requirements, even though submittal data may have been accepted previously. Equipment rejected after delivery shall be marked for identification and shall be removed from the job site at once.

1.06 SYSTEM DESCRIPTION

A. The equipment and materials specified herein are intended to be standard for use in controlling the flow of water as noted on the Drawings.

B. Valves, appurtenances and miscellaneous items shall be installed as shown on the Drawings and as specified, so as to form complete workable systems.

C. Unless otherwise noted powered valve operators shall have:

1. Valves larger than 3-in: electric operators 480 Volt, 3 Phase, 60 Hz.

1.07 DELIVERY, STORAGE AND HANDLING

A. Packing and Shipping

1. Care shall be taken in loading, transporting and unloading to prevent injury to the valves, appurtenances, or coatings. Equipment shall not be dropped. Valves and appurtenances shall be examined before installation and no piece shall be installed which is found to be defective. Any damage to the coatings shall be repaired as acceptable to the OWNER.

2. Prior to shipping, the ends of valves shall be acceptably covered to prevent entry of foreign material. Covers shall remain in place until after installation and connecting piping is completed.

    a. Valves 3-in and larger shall be shipped and stored on site until time of use with wood or plywood covers on each valve end.

    b. Rising stems and exposed stem valves shall be coated with a protective oil film which shall be maintained until the valve is installed and put into use.

    c. Any corrosion in evidence at the time of acceptance by the Owner shall be removed, or the valve shall be removed and replaced.

B. Storage and Protection

1. Special care shall be taken to prevent plastic and similar brittle items from being directly exposed to the sun, or exposed to extremes in temperature, to prevent deformation. See the individual piping sections and manufacturer's information for further requirements.

1.08 MAINTENANCE

A. Special tools and the manufacturer's standard spare parts, if required for normal operation and maintenance, shall be supplied with the equipment where noted, as specified herein. Tools shall be packaged in a steel case, clearly and indelibly marked on the exterior to indicate equipment for which tools are intended.

B. Provide one Operations and Maintenance manual for each type of valve and operator supplied under this specification.

C. Included within the Operations and Maintenance manuals, provide a list of spare and replacement parts with individual prices and location where they are available.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT - GENERAL

A. Valves and appurtenances shall have the name of the maker, nominal size, flow directional arrows, working pressure for which they are designed and standard referenced, cast in raised letters or via riveted stainless steel nameplate upon some appropriate part of the body.

B. Actuators for valves shall be delivered to the jobsite installed on the valve for which it is intended. Field assembly of the actuator to the valve is not allowed.

C. Unless otherwise noted, items shall have a minimum working pressure of 150 psi or be of the same working pressure as the pipe they connect to, whichever is higher and suitable for the pressures noted where they are installed.

D. Joints, size and material - unless otherwise noted or required by the Owner:

1. Except where noted, joints referred to herein shall be of the same type, nominal diameter, material and with a minimum rating equal to the pipe or fittings they are connected to.

2. Valves and appurtenances shall be of the same nominal diameter as the pipe or fittings they are connected to.

3. Valves exposed to view, or in vaults:

   a. 4-in and larger - flanged ends.

E. Provide special adaptors as required to ensure compatibility between valves, appurtenances and adjacent pipe.

F. Valves and actuators located in vaults; or where otherwise noted shall be especially designed for submerged service where water may completely submerge the valve and operator.

2.02 VALVE ACTUATORS – POWERED

A. General

1. The actuators shall conform to AWWA Standard C540, insofar as applicable and as herein specified. Actuators installed in vaults below grade and elsewhere subject to submergence shall be watertight to standard NEMA 6P/IP68, 15 ft for 72 hours minimum.

2. Valve service/operation shall be as indicated on the P&IDs.

3. 480 Volt powered actuators shall be EIM TEK 2000 no equal. Actuators shall be configured as required to provide for part turn or multi-turn and be coupled with gearboxes as required to obtain the speed and operating torque as required for the valve it controls.

B. 480 Volt Powered Actuators for Part Turn Valve Operation

1. Operation

   a. Capabilities shall be provided to position the valve locally via the Local/Off/Remote selector switch and Open/Stop/Close push buttons.

   b. For on/off service, when in remote, the actuator shall accept one remote signal to open the valve or gate and a second remote signal to close the valve or gate.

   c. Unless stated otherwise in the valve specifications or based on a pipeline surge analysis, quarter turn valves shall rotate from stop to stop in 30 seconds per foot of throat diameter.

2. Functional

   a. The motor operated valve controller shall include the motor, operator unit gearing, limit switch gearing, limit switches, control power transformer, position transmitter (when required), torque switches, bored and key-wayed drive sleeve for non-rising stem valves, declutch lever and auxiliary handwheel as a self-contained unit. Valve contacts shall be capable of handling the current equivalent of a NEMA 1 size starter.

b. Reversing starters shall be integral with the actuator, and shall be solid-state starters for modulating service. Electro-mechanical reversing starters shall be acceptable for open-close service and shall be mechanically and electrically interlocked.

c. Limit switches and gearing shall be an integral part of the valve control. The limit switch gearing shall be made of bronze or stainless steel and shall be fully lubricated, intermittent type and totally enclosed to prevent dirt and foreign matter from entering the gear train. Limit switches shall be of the adjustable type capable of being adjusted to trip at any point between fully opened valve and fully closed valve. Limit and torque switches shall be provided for stopping valve in both directions. Mid-travel switches shall be provided as required. Set position shall not be lost if over travel occurs in either manual or electric modes of operation.

d. The speed of the actuator shall be the responsibility of the system supplier with regards to hydraulic requirements and response compatibility with other components within the control loop. Each valve controller shall be provided with a minimum of two limit switch functions, one for opening and one for closing. Each limit switch will have two normally open and two normally closed contacts. Gear limit switches must be geared to driving mechanism and in step whether in motor or manual operation. Provision shall be made for two extra sets of limit switches as described above, each to have two normally open and two normally closed contacts. Each valve controller shall be equipped with a double torque switch. The torque switch shall be adjustable and will be responsive to load encountered in either direction of travel. The limit and torque switch contacts shall be silver inlay type.

e. Each actuator shall include monitor relays to remotely indicate fault signal for indication of power failure, phase failure, thermal switch tripped, torque switch tripped between travel stops and Local-Off-Remote selector switch position.

3. Physical

a. The operator shall be equipped with open-stop-close push-buttons, a local-off-remote selector switch and indicating lights mounted on the operator.

b. The motor shall operate on 480 volt, 60 hertz, 3 phase power and shall be sized by the actuator manufacturer to provide the required output torque for the service intended. The motor shall have Class F insulation, with a duty rating of at least 15 minutes at 40 degrees C ambient temperature. The motor shall be specifically designed and built by the actuator manufacturer for electric actuator service. Commercially available motors shall not be acceptable. The actuator shall include a device to ensure that the motor runs with the correct rotation for the required direction of valve travel regardless of the connection sequence of the power supply.

c. Operators utilizing multiple reduction power gearing shall consist of spur, helical, or bevel gearing and worm of hardened alloy steel, and the worm gear shall be alloy bronze. Operators utilizing single-stage reduction shall be single-stage worm gear totally enclosed in a fully lubricated gearcase, with filling and drain plugs. Non-metallic, aluminum, or cast gearing shall not be allowed. The output shaft shall incorporate thrust bearings of the ball or roller type at the base of the actuator.

d. An operating wheel shall be provided for manual and/or emergency operation, engaged when the motor is declutched by a lever or similar means, the drive being restored to power automatically by starting the motor. The operating wheel drive must be mechanically independent of the motor drive, and any gearing shall be such as to permit emergency manual operation, using a 40 pound force in a reasonable time. Clockwise operation of the handwheel shall give closing movement of the valve unless otherwise stated.

e. Each actuator shall be supplied with a start-up kit including installation instructions, wiring diagrams, and spare cover screws and seals to provide for losses during commissioning.

f. Continuous mechanical dial indication of valve and position shall be provided. The mechanical dial position indicator shall be in step with the actuator in both the hand wheel and motor operation.

4. Wiring and Terminals

a. Internal wiring shall be of tropical grade PVC insulated stranded cable of 5 amp minimum rating for control circuits and of appropriate size for the motor 3 phase power. Each wire shall be clearly identified at each end.

b. The terminals shall be of the stud type embedded in a terminal block of high tracking-resistance compound. The 3-phase power terminals shall be shrouded from the control terminals by means of an insulating cover.

c. The terminal compartment shall be separated from the inner electrical components of the actuator by means of a watertight seal. The terminal compartment of the actuator shall be provided with three threaded cable entries.

d. Each actuator shall be provided with a commissioning kit consisting of a wiring diagram and installation and operation manual. A separate wiring diagram shall be provided inside the terminal cover. No special tools, devices or parts shall be required for commissioning.

e. Actuators shall have separately sealed motor and control compartments. Operators shall have space heaters in their limit switch, motor, and control compartments.

5. Performance Test

Each actuator must be shop performance tested, and individual test certificates shall be supplied without additional charge to the Owner. Test certificates shall be submitted prior to shipment of valve actuators. The test equipment shall simulate a typical valve load, and the following parameters shall be recorded:

a. No load current
b. Current at maximum torque setting
c. Stall current
d. Torque at maximum torque setting
e. Stall torque
f. Test voltage and frequency

g. Flash test voltage
h. Actuator output speed

2.03 SURFACE PREPARATION AND SHOP COATINGS

A. The exterior surface of various parts of valves, operators, floor-stands and miscellaneous piping shall be thoroughly cleaned of scale, dirt, grease or other foreign matter and thereafter one shop coat of an approved rust-inhibitive primer such as Inertol Primer No. 621 shall be applied in accordance with the instructions of the paint manufacturer or other primer compatible with the finish coat provided.

B. Unless otherwise noted, interior ferrous surfaces of valves shall be given a shop finish of an asphalt varnish conforming to AWWA C509, (except mounting faces/surfaces) or epoxy conforming to AWWA C550 with a minimum thickness of 6 mils.

C. Ferrous surfaces obviously not to be painted shall be given a shop coat of grease or other suitable rust-resistant coating. Mounting surfaces shall be especially coated with a rust preventative.

D. Special care shall be taken to protect uncoated items and plastic items, especially from environmental damage.

2.04 FACTORY INSPECTION AND TESTING

A. Factory inspection, testing and correction of deficiencies shall be done in accordance with the referenced standards and as noted herein.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

A. Valve actuators and appurtenances shall be installed per the manufacturer's instructions in the locations shown, true to alignment and rigidly supported. Any damage to the above items shall be repaired to the satisfaction of the OWNER before they are installed.

B. Install brackets, extension rods, guides, the various types of operators and appurtenances as shown on the Drawings, or otherwise required. Before setting these items, check Drawings and figures which have a direct bearing on their location to insure that valves, actuators and appurtenances are properly located during the construction of the work.

C. Materials shall be carefully inspected for defects in construction and materials. Debris and foreign material shall be cleaned out of openings, etc. Valve flange covers shall remain in place until connected piping is in place. Operating mechanisms shall be operated to check their proper functioning and nuts and bolts checked for tightness. Valves and other equipment which do not operate easily, or are otherwise defective, shall be repaired or replaced at no additional cost to the Owner.

D. Where installation is covered by a referenced standard, installation shall be in accordance with that standard, except as herein modified. Also note additional requirements in other parts of this Section.

E. Unless otherwise noted, joints for valves and appurtenances shall be made up utilizing the same procedures as specified under the applicable type connecting pipe joint and valves and other items shall be installed in the proper position as recommended by the manufacturer. Verify manufacturers' torque requirements for valves and install per manufactures requirements.

3.02 INSPECTION, TESTING AND CORRECTION OF DEFICIENCIES

A. Take care not to over pressure valves or appurtenances during pipe testing. If any unit proves to be defective, it shall be replaced or repaired to the satisfaction of the Owner.

B. Functional Test: Prior to plant startup, items shall be inspected for proper alignment, quiet operation, proper connection and satisfactory performance. After installation, manual valves shall be opened and closed in the presence of the Owner to show the valve operates smoothly from full open to full close and without leakage. Valves equipped with electric actuators shall by cycled 5 times from full open to full closed in the presence of the Owner without vibration, jamming, leakage, or overheating.

END OF SECTION

DIVISION 16

ELECTRICAL

SECTION 16020

ELECTRICAL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Conduit, wire and field connections for valves, valve controllers and electrical equipment.

B. Conduit, wiring and terminations for field-mounted instruments furnished and mounted under other Divisions of these Specifications, including process instrumentation primary elements, transmitters, local indicators and control panels. Install vendor furnished cables specified under other Divisions of these Specifications.

C. Underground System

1.02 RELATED WORK

A. Excavation and backfilling, including gravel or sand bedding for underground electrical work is included in Division 2.

B. Cast in place concrete work, including equipment pads, light pole bases and reinforcing steel, is included in Division 3.

1.03 SUBMITTALS

A. Submit, shop drawings for equipment, materials and other items furnished under Division 16.

B. Check shop drawings for accuracy and contract requirements prior to submittal. Shop drawings shall be stamped with the date checked and a statement indicating that the shop drawings conform to Specifications and Drawings. This statement shall also list exceptions to the Specifications and Drawings. Shop drawings not so checked and noted shall be returned.

C. Dimensions shall be field verified at the job site and coordinated with the work of other trades.

D. Installation, Operation, and Maintenance Manuals

1. Submit operations and maintenance data for equipment furnished under this Division.

1.04 CONTRACT PERFORMANCE REQUIREMENTS

A. Electric equipment, materials and installation shall comply with the National Electrical Code (NEC) and with the following codes and standards:

1. National Electrical Safety Code (NESC)

2. Occupational Safety and Health Administration (OSHA)

3. National Fire Protection Association (NFPA)

4. National Electrical Manufacturers Association (NEMA)

5. American National Standards Institute (ANSI)

6. Insulated Cable Engineers Association (ICEA)

7. Instrument Society of America (ISA)

8. Underwriters Laboratories (UL)

9. Factory Mutual (FM)

10. National Electrical Testing Association (NETA)

1.05 ENCLOSURE TYPES

A. Unless otherwise specified electrical enclosures shall have the following ratings:

1. NEMA 4X for outdoor locations.

1.06 CODES, INSPECTION AND FEES

A. Equipment, materials and installation shall comply with the requirements of the local authority having jurisdiction.

B. Obtain necessary permits and pay fees required for permits and inspections.

1.07 TESTS AND SETTINGS

A. Test systems and equipment furnished under Division 16 and repair or replace defective work and equipment. Refer to the individual equipment sections for additional specific testing requirements.

B. Make adjustments to the systems and instruct the Owner's personnel in the proper operation of the systems.

C. In addition to the specific testing requirements listed in the individual sections, the following minimum tests and settings shall be performed.

1. Mechanical inspection, testing and settings of circuit breakers, disconnect switches, protection relays, overload relays, control circuits and equipment for proper operation.

2. Check power and control power fuse ratings. Replace fuses if they are found to be of the incorrect size.

3. Verify terminations at transformers, equipment, panels and enclosures by producing a 1, 2, 3 rotation on a phase sequenced motor when connected to "A," "B" and "C" phases.

4. Test the grounding system using the three point fall in potential method.

5. Test 600 Volt wire insulation with a meg-ohm meter after installation. Make tests at not less than 500V. Submit a written test report of the results to the OWNER.

D. Testing shall be scheduled and coordinated with the Owner at least two weeks in advance. Provide qualified test personnel, instruments and test equipment.

1.08 RECORD DRAWINGS

A. As the work progresses, legibly record field changes on a set of project contract drawings, hereinafter called the "record drawings."

B. Record drawings shall accurately show the installed condition of the following items:

1. One-line Diagram(s).

2. Raceways and pullboxes.

3. Conductor sizes and conduit fills.

4. Control Wiring Diagram(s).

5. Underground raceway routing.

6. Plan view, sizes and locations of panelboards.

C. Submit a schedule of control wiring raceways and wire numbers, including the following information:

1. Circuit origin, destination and wire numbers.

2. Field wiring terminal strip names and numbers.

D. As an alternate, point-to-point connection diagrams showing the same information may be submitted in place of the schedule of control wiring raceways and wire numbers.

E. Submit the record drawings and the schedule of control wiring raceways and wire numbers (or the point-to-point connection diagram) to the Owner.

1.09 EQUIPMENT INTERCONNECTIONS

A. Review shop drawings of equipment furnished under other Divisions of this Specification and prepare coordinated wiring interconnection diagrams or wiring tables. Submit copies of wiring diagrams or tables with Record Drawings.

B. Furnish and install equipment interconnections.

1.10 MATERIALS AND EQUIPMENT

A. Materials and equipment shall be new.

B. Material and equipment of the same type shall be the product of one manufacturer and shall be UL listed.

C. Provide Quality Control.

D. Warrant equipment furnished under Division 16. Refer to individual equipment sections for additional warranty items.

1.11 EQUIPMENT IDENTIFICATION

A. Identify equipment (disconnect switches, separately mounted motor starters, control stations, etc) furnished under Division 16 with the name of the equipment it serves. Motor control centers, control panels, panelboards, switchboards, switchgear, junction or terminal boxes, transfer switches, etc, shall have nameplate designations as shown on the Drawings.

B. Nameplates shall be engraved, laminated plastic, not less than 1/16-in thick by 3/4-in by 2-1/2-in with 3/16-in high white letters on a black background.

C. Nameplates shall be screw mounted to NEMA 1 enclosures. Nameplates shall be bonded to other enclosure types using an epoxy or similar permanent waterproof adhesive. Two sided foam adhesive tape is not acceptable. Where the equipment size does not have space for mounting a nameplate the nameplate shall be permanently fastened to the adjacent mounting surface.

1.12 INTERPRETATION OF DRAWINGS

A. Unless specifically stated to the contrary, the Drawings are not intended to show exact locations of conduit runs. Coordinate the conduit installation with other trades and the actual supplied equipment.

B. Install each 3 phase circuit in a separate conduit unless otherwise shown on the Drawings.

C. Unless otherwise approved by the OWNER, conduit shown exposed shall be installed exposed; conduit shown concealed shall be installed concealed.

D. Where circuits are shown as "home-runs" necessary fittings and boxes shall be provided for a complete raceway installation. Where home-runs indicate conduit is to be installed concealed or exposed the entire branch circuit shall be installed in the same manner. Unless otherwise indicated install branch circuit conduits exposed in process/industrial type spaces and concealed in finished spaces.

E. Except where dimensions are shown, the locations of equipment, fixtures, outlets and similar devices shown on the Drawings are approximate only. Exact locations shall be determined by the Contractor and approved by the OWNER during construction. Obtain information relevant to the placing of electrical work and in case of any interference with other work, proceed as directed by the OWNER and furnish labor and materials necessary to complete the work in an approved manner.

F. Circuit layouts are not intended to show the number of fittings, or other installation details. Furnish labor and materials necessary to install and place in satisfactory operation power, and other electrical systems shown.

G. Redesign of electrical or mechanical work, which is required due to the Contractor's use of an alternate item, arrangement of equipment and/or layout other than specified herein, shall be done by the Contractor at his/her own expense. Redesign and detailed plans shall be submitted to the OWNER for approval. No additional compensation will be provided for changes in the work, either his/her own or others, caused by such redesign.

H. It is the intent of these Specifications that the Electrical Systems shall be suitable in every way for the service required. Materials and work that may be implied as being incidental to the work of this Section shall be furnished at no additional cost to the Owner.

1.13 SEISMIC RESTRAINTS

A. Seismic anchorage and restraints shall be provided for electrical systems including but not limited to conduits, busways, cable trays, pull boxes, free standing or wall mounted panels and cabinets, disconnect switches, and other similar electrical equipment installed under Division 16.

B. Seismic design criteria per Section 01615.

PART 2 PRODUCTS

2.01 CONDUITS AND FITTING

A. Rigid Steel Conduit

1. Rigid steel conduit interior and exterior shall be hot-dipped galvanized and be as manufactured by the Allied Tube and Conduit Corp.; Wheatland Tube Co.; Triangle PWC Inc. or equal.

B. Rigid Nonmetallic Conduit

1. PVC conduit shall be rigid polyvinyl chloride schedule 40 and 80 as manufactured by Carlon; An Indian Head Co.; Kraloy Products Co., Inc.; Highland Plastics Inc. or equal.

C. Liquidtight Flexible Metal Conduit, Couplings and Fittings

1. Liquidtight flexible metal conduit shall be Sealtite, Type UA, manufactured by the Anaconda Metal Hose Div.; Anaconda American Brass Co.; American Flexible Conduit Co., Inc.; Universal Metal Hose Co. or equal.

2. Fittings used with liquidtight flexible metal conduit shall be of the screw-in type as manufactured by the Thomas & Betts Co.; Crouse-Hinds Co. or equal.

D. Flexible Couplings

1. Flexible couplings shall be type ECGJH as manufactured by the Crouse-Hinds Co.; Appleton Electric Co.; Killark Electric Manufacturing Co. or equal.

E. Boxes and Fittings

1. NEMA 4X terminal boxes, junction boxes, pull boxes, etc, shall be sheet stainless steel unless otherwise shown on the Drawings. Boxes shall have continuously welded seams and mounting feet. Welds shall be ground smooth. Boxes shall be flanged and shall not have holes or knockouts. Box bodies shall not be less than 14 gauge metal and covers shall not be less than 12 gauge metal. Covers shall have a continuous gasket on four sides and be fastened with stainless steel clamps. Terminal boxes shall be furnished with hinged doors, terminal mounting straps and brackets. Terminal blocks shall be NEMA type, not less than 20 Amp, 600 Volt. Boxes shall be as manufactured by Hoffman Engineering Co.; Lee Products Co.; Keystone/Rees, Inc. or equal.

2. Conduit hubs shall be as manufactured by Myers Electric Products, Inc. or equal.

3. Conduit sealing bushings shall be O.Z./Gedney Type CSB or equal.

F. Conduit Mounting Equipment

1. Hangers, rods, backplates, beam clamps, channel, etc. shall be galvanized iron or steel.

2. PVC coated steel channel with stainless steel hardware shall be used in areas designated "WET" and "CORROSIVE" on the Drawings and in outdoor locations. Fiberglass channel shall be resistant to the chemicals present in the area in which it is used.

G. Cold Galvanizing Compound

1. Cold galvanizing compound shall be as manufactured by ZRC Products Company, a division of Norfolk Corp. or equal.

2.02 WIRE, CABLE AND ACCESSORIES

A. Wires and cables shall be of annealed, 98 percent conductivity, soft drawn copper.

B. Conductors shall be stranded, except that lighting and receptacle wiring may be solid.

C. Except for control, signal and instrumentation circuits, wire smaller than No. 12 AWG shall not be used.

D. Wire for lighting, receptacles and other circuits not exceeding 150 Volts to ground shall be NEC Type THHN/THWN as manufactured by Okonite Co.; Southwire Co.; Pirelli Corp., or equal.

E. Wire for circuits over 150 Volts to ground shall be NEC type THHN/THWN as manufactured by Okonite Co.; Southwire Co., or equal.

F. Wire for control, status and alarm circuits shall be No.14 AWG NEC type THHN/THWN, stranded as manufactured by the Okonite Co.; Carol Cable Co. Inc. West; Pirelli Cable Corp. or equal.

G. Wire for process instrumentation signals (i.e., 1-5 VDC, 4-20 mA), R.T.D., potentiometer and similar signals shall be:

1. Single pair cable:

Conductors:	2- No.16 stranded and twisted on 2-in lay
Insulation:	PVC with 300 Volt, 105 degrees C rating
Shield:	100 percent mylar tape with drain wire
Jacket:	PVC with UL Subject 13, UL 1581, and manufacturer's identification
Max overall diameter:	0.262-in
Miscellaneous	UL listed for underground wet location use
Manufacturers:	Belden No. 1030 or equal

H. Termination connectors for control wiring shall be of the locking fork-end (upturned leg ends) type as manufactured by Ideal Industries; 3M Co.; Panduit Corp. or equal.

I. Termination connectors for shielded instrumentation wiring shall be of the locking fork-end (upturned leg ends) type as manufactured by Ideal Industries; 3M Co.; Panduit Corp. or equal.

J. Wire markers shall be "Omni-Grip" as manufactured by the W.H. Brady Co.; Thomas & Betts Co.; 3M Co. or equal.

2.03 MISCELLANEOUS EQUIPMENT

A. Disconnect Switches

1. Disconnect switches shall be heavy-duty, quick-make, quick-break, visible blades, 600 Volt, 3 Pole with full cover interlock, interlock defeat and flange mounted operating handle.

2. NEMA 4X enclosures shall be stainless steel.

3. Switches shall be as manufactured by the Square D Co.; Cutler Hammer Co.; General Electric Company; Siemens Company or equal.

B. Circuit Breakers

1. Provide thermal magnetic circuit breaker in NEMA Type 4X Enclosure with externally operated handle. Circuit breakers shall be fully rated for 22,000 Amps RMS symmetrical.

2. Circuit breakers shall be manufactured by Cutler Hammer Co.; General Electric Company; Siemens Company or equal.

C. Control Stations

1. Control stations shall be heavy-duty type, with full size operators. Momentary contact stop buttons shall have a lockout latch that can be padlocked in the open position.

2. NEMA 4X enclosures shall be stainless steel.

3. Control stations shall be Square D Class 9001; Cutler Hammer Co.; General Electric Company; Allen Bradley Company or equal.

D. Polyethylene Warning Tape

1. Warning tape shall be red polyethylene film, 6-in minimum width.

2. Warning tape shall be W.H. Brady Co., Catalog No. 91296 or equal.

E. Equipment Mounting Stands

1. Equipment mounting stands shall be custom fabricated from 1/4-in steel plate and 4-in steel channel, as shown on the Drawings.

2. Hot dip galvanizing shall conform to the requirements of Division 5.

2.04 PANELBOARDS

A. Panelboards shall be in accordance with the Underwriter Laboratories, Inc. "Standard for Panelboards" and "Standard for Cabinets and Boxes" and shall be so labeled where procedures exist. Panelboards shall also comply with NEMA Standard for Panelboards and the National Electrical Code.

B. 480 Volt, 3 Phase, 3 Wire NEMA 4X panelboards shall be Type Pow-R-Line 3a as manufactured by Eaton, or equal.

C. Rating

1. Panelboards shall be rated for the intended voltage.

2. Circuit breaker panelboards shall be fully rated for the specified circuit breaker fault current interrupting capacity. Series connected short circuit ratings will not be acceptable.

D. Buses

1. Bus bars for the mains shall be of copper. Full size neutral bars shall be included. Phase bussing shall be full height without reduction. Cross connectors shall be copper.

2. Neutral bussing shall have a suitable lug for each outgoing feeder requiring a neutral connection.

3. Spaces for future circuit breakers shall be bussed for the maximum device that can be fitted into them.

4. Equipment ground bars shall be furnished.

E. Circuit Breakers

1. Panelboards shall be equipped with circuit breakers.

2. Circuit breakers shall be molded case, bolt-in type.

3. Each circuit breaker used in 277/480 Volt and 480 Volt panelboards shall have an interrupting capacity of not less than 10,000 amperes RMS symmetrical.

4. Circuit breakers shall be as manufactured by the panelboard manufacturer.

PART 3 EXECUTION

3.01 CUTTING AND PATCHING

A. Core drill holes in concrete floors and walls as required.

B. Install work at such time as to require the minimum amount of cutting and patching.

C. Do not cut joists, beams, girders, columns or any other structural members.

D. Cut opening only large enough to allow easy installation of the conduit.

E. Patching to be of the same kind and quality of material as was removed.

F. The completed patching work shall restore the surface to its original appearance or better.

G. Patching of waterproofed surfaces shall render the area of the patching completely waterproofed.

H. Remove rubble and excess patching materials from the premises.

I. When existing conduits are cut at the floor line of wall line, they shall be filled with grout of suitable patching material.

3.02 INSTALLATION

A. Any work not installed according to the Specifications shall be subject to change as directed by the OWNER. No extra compensation will be allowed for making these changes.

B. Electrical equipment shall be protected against mechanical injury or damage by water. Electrical equipment shall not be stored outdoors. Electrical equipment shall be stored in dry permanent shelters. Do not install electrical equipment in its permanent location until structures are weather-tight. If any apparatus has been subject to possible injury by water, it shall be thoroughly dried out and tested as directed by the OWNER, or shall be replaced at no additional cost at the OWNER's discretion.

C. Equipment that has been damaged shall be replaced or repaired by the equipment manufacturer, at the OWNER's discretion.

D. Repaint any damage to factory applied paint finish using touch-up paint furnished by the equipment manufacturer. The entire damaged panel or section shall be repainted at no additional cost to the Owner.

E. Coordinate the conduit installation with others and the actual supplied equipment.

F. Install each 3 phase circuit in separate conduit.

G. Unless otherwise approved by the OWNER, conduit installed interior to the building shall be installed exposed; conduit installed exterior to the building shall be concealed.

H. Exact locations of electrical equipment shall be determined by the Contractor and approved by the Owner during construction. Obtain information relevant to the placing of electrical work and in case of any interference with other work, proceed as directed by the Owner and furnish labor and materials necessary to complete the work in an approved manner.

3.03 BOXES AND FITTINGS

A. Except where otherwise specified, wiring shall be in rigid steel conduit.

B. Rigid steel conduit shall be used (underground and within structures) as raceways for shielded process instrumentation wiring, shielded control wiring, and I/O wiring.

C. Boxes shall be metal.

D. Terminal boxes, junction boxes and pull boxes shall have NEMA ratings suitable for the location in which they are installed.

E. Conduit wall seals shall be used where underground conduits penetrate walls.

F. Conduit sealing bushings shall be used to seal conduit ends exposed to the weather.

G. No conduit smaller than 3/4-in electrical trade size shall be used, nor shall any have more than the equivalent of three 90 degree bends in any one run. Pull boxes shall be provided as required or directed.

H. No wire shall be pulled until the conduit system is complete.

I. The ends of conduits shall be tightly plugged to exclude dust and moisture during construction.

J. Conduit supports, other than for underground raceways, shall be spaced at intervals of 8-ft or less.

K. Conduit hangers shall be attached to structural steel by means of beam or channel clamps. Where attached to concrete surfaces, concrete inserts of the spot type shall be provided.

L. Conduits shall be run at right angles to and parallel with the surrounding wall and shall conform to the form of the ceiling. No diagonal runs will be allowed. Bends in parallel conduit runs shall be concentric. Conduits shall be run perfectly straight and true.

M. Conduit terminating in pressed steel boxes shall have double locknuts and insulated bushings.

N. Conduit terminating in NEMA 3R, 4, 4X and 12 enclosures shall be terminated with Myers type conduit hubs.

O. Conduits containing equipment grounding conductors and terminating in sheet steel boxes shall have insulated throat grounding bushings.

P. Conduits shall be installed using threaded fittings.

Q. PVC conduit to non-metallic box connections shall be made with PVC socket to male thread terminal adapters with neoprene O-ring and PVC round edge bushings.

R. Conduit ends exposed to the weather shall be sealed with conduit sealing bushings.

S. PVC conduit shall be supported with non-metallic clamps, PVC coated steel racks and stainless steel hardware.

T. PVC boxes, conduit fittings, etc. with integral hubs shall be solvent welded directly to the PVC conduit system.

U. Non-metallic boxes with field drilled or punched holes shall be connected to the PVC conduit system with threaded and gasketed PVC Terminal Adapters.

V. Conduit which may under any circumstance contain liquids such as water, condensation, liquid chemicals, etc, shall be arranged to drain away from the equipment served. If conduit drainage is not possible, conduit seals shall be used to plug the conduits.

W. Where no type or size is indicated for junction boxes, pull boxes or terminal cabinets, they shall be sized in accordance with the requirements of N.E.C. Article 370.

X. Miscellaneous steel for the support of fixtures, boxes, transformers, starters, contactors, panels and conduit shall be furnished and installed.

Y. Steel channels, flat iron and channel iron shall be furnished and installed for the support of electrical equipment and devices, where required, including anchors, inserts, bolts, nuts, washers, etc. for a rigid installation.

Z. Rigid galvanized steel conduits which have been field cut and threaded shall be painted with cold galvanizing compounds.

3.04 WIRE, CABLE AND ACCESSORIES

A. Uniquely identify wires, cables and each conductor of multi- conductor cables (except lighting and receptacle wiring) at each end with wire and cable markers.

B. Use lubrications to facilitate wire pulling. Lubricants shall be UL approved for use with the insulation specified.

C. Wire shall be color coded or coded using electrical tape in sizes where colored insulation is not available. Where tape is used as the identification system, it shall be applied in junction boxes, and other accessible intermediate locations as well as at each termination.

D. The following coding shall be used:

System	Wire	Color
240/120 Volts 1-Phase, 3-Wire	Neutral	White
	Line 1	Black
	Line 2	Red
208Y/120, Volts 3-Phase, 4-Wire	Neutral	White
	Phase A	Black
	Phase B	Red
	Phase C	Blue
240/120 Volts 3-Phase, 4-Wire delta, center tap ground on phase coil A-C	Neutral	White
	Phase A	Black
	Phase B (High)	Orange
	Phase C	Blue
480Y/277 Volts 3-Phase, 4-Wire	Neutral	White
	Phase A	Brown
	Phase B	Orange
	Phase C	Yellow

E. Power conductors: Terminations shall be die type or set screw type pressure connectors as specified. Splices (where allowed) shall be die type compression connector and waterproof with heat shrink boot or epoxy filling. Aluminum conductors (where specified) shall employ terminations and splices specifically designed for aluminum conductors.

F. Control Conductors: Termination on saddle-type terminals shall be wired directly with a maximum of two conductors. Termination on screw type terminals shall be made with a maximum of two spade connectors. Splices (where allowed) shall be made with insulated compression type connectors.

G. Instrumentation Signal Conductors (including graphic panel, alarm, low and high level signals): terminations same as for control conductors. Splices allowed at instrumentation terminal boxes only.

H. Splices shall not be made in push button control stations, control devices (i.e., pressure switches, flow switches, etc.), conduit bodies, etc.

I. Instrumentation cables shall be installed in rigid steel raceways as specified. Circuits shall be installed as twisted pairs or triads. In no case shall a circuit be made up using conductors from different pairs or triads. Triads shall be used wherever three wire circuits are required.

J. Shielded instrumentation wire, shall be run without splices between instruments, terminal boxes, or panels.

K. Shields shall be grounded as recommended by the instrument manufacturer and isolated at other locations. Terminal blocks shall be provided for inter-connecting shield drain wires at junction boxes. Where individual circuit shielding is required, each shield circuit shall be provided with its own block.

3.05 PANELBOARDS

A. Mount boxes for surface mounted panelboards so there is at least 1/2-in air space between the box and the wall.

B. Type circuit directories giving location and nature of load served. Install circuit directories in each panelboard.

C. Install markers on the front cover of panelboards which identify the voltage rating. Markers shall be made of self sticking B-500 vinyl cloth printed with black characters on an Alert Orange background, 2-1/4-in high by 9-in wide, Style A as manufactured by W.H. Brady Co. or equal.

D. Install a 1-in by 3-in laminated plastic nameplate with 1/4-in white letters on a black background on each panelboard. Nameplate lettering shall be as shown on the Drawings. Nameplates shall be stainless steel screw mounted.

3.06 UNDERGROUND SYSTEM

A. The minimum cover for raceway banks shall be 24-in unless otherwise permitted by the OWNER.

B. Swab raceways clean before installing cable.

C. Plug spare raceways and seal them watertight at manholes, buildings and structures.

D. Seal the ends of raceways and make watertight at handholes, buildings and structures.

3.07 GROUNDING

A. Run grounding electrode conductors in rigid steel conduits. Bond the protecting conduits to the grounding electrode conductors at both ends. Do not allow water pipe connections to be painted. If the connections are painted, disassemble them and re-make them with new fittings.

B. Install equipment grounding conductors with feeders and branch circuits.

C. Liquid tight flexible metal conduit in sizes 1-1/2-in and larger shall have bonding jumpers. Bonding jumpers shall be external, run parallel (not spiraled) and fastened with plastic tie wraps.

D. Seal exposed connections between different metals with No-Oxide Paint Grade A or equal.

E. Lay underground grounding conductors slack and, where exposed to mechanical injury, protect by pipes or other substantial guards. If guards are iron pipe, or other magnetic material, electrically connect conductors to both ends of the guard. Make connections as specified herein.

F. Care shall be taken to ensure maximum 5 ohms, in particular between the conduit system and equipment frames and enclosures. Where necessary, jumper wires shall be installed.

G. Test the grounding system. Resistance to ground testing shall be performed during dry season. Submit test results in the form of a graph showing the number of points measured (12 minimum) and the numerical resistance to ground.

H. Testing shall be performed before energizing the distribution system.

I. Notify the Owner immediately if the resistance to ground for any building or system is greater than five ohms.

END OF SECTION

Segment 2:

Huichica Unit

DIVISION 2

SITE CONSTRUCTION

SECTION 02140

DEWATERING

PART 1 GENERAL

1.1 DESCRIPTION

A. The Contractor shall dewater as necessary to lower and control groundwater levels and hydrostatic pressures to allow excavation and construction under dry conditions. This Section includes materials, installation, maintenance, operation, and removal of temporary dewatering systems.
B. The Contractor shall treat groundwater removed as necessary for its legal disposal.
C. Dewatering operations shall be adequate to ensure the integrity of the finished project.

1.2 REFERENCE SPECIFICATIONS, PERMITS, CODES AND STANDARDS

A. The Contractor shall be prepared for dewatering activities and shall treat and legally dispose of the groundwater in compliance with all Federal, State and Local regulations and the requirements of the permits relating to discharge of uncontaminated groundwater from construction dewatering.
B. Comply with State Water Resources Control Board General Permit for Storm Water Discharges Associated with Construction and Land Disturbance Activity, Order No. 2009-0009-DWQ as amended by 2010-0014-DWQ or, alternatively; dispose of dewatering water in manner that is not subject to permitting by the California Regional Water Quality Control Board. See Section 01100 Summary.
C. The Contractor shall comply with all applicable sampling, testing, monitoring, and reporting requirements.

1.3 SUBMITTALS

A. The following shall be submitted:
   1. Shop Drawings, including a detailed plan, schedule, and description of the dewatering of excavations. The Shop Drawings shall include: the proposed type of dewatering system; the arrangement, location, and depths of system components; a complete description of the equipment and instrumentation to be used, with installation, operation and maintenance procedures; a description of the Contractor's means and methods for measuring groundwater levels and piezometric water levels; and the methods for disposal of dewatering effluent.

1.4 QUALITY ASSURANCE

A. The Contractor shall conduct a demonstration of its proposed system and shall provide verification that adequate personnel, materials and equipment are available.
B. The Contractor shall maintain adequate control to ensure that the stability of excavated and constructed slopes is not adversely affected by water, that erosion is controlled, and that flooding of excavations or damage to structures does not occur.
C. Protect the retaining walls, slide gates and culverts during all construction activities.

PART 2 MATERIALS

2.1 MATERIALS AND EQUIPMENT

A. Dewatering, where indicated, includes well points, sump pumps, treatment facilities, temporary pipelines for water disposal, rock or gravel placement, and other means including standby pumping equipment maintained on the jobsite continuously.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

A.

B. The Contractor shall maintain an adequate system to lower and control the groundwater to permit excavation, construction of structures, and placement of fill materials under dry conditions.

C. Sufficient dewatering equipment shall be installed to pre-drain the water-bearing strata below the bottom of proposed structures and excavations.

D. The hydrostatic head in water-bearing strata shall be reduced to ensure that the water level is below the proposed structures and excavations at all times.

E. Dewatering shall at all times be conducted to preserve the undisturbed bearing capacity of the subgrade soils at proposed bottom of excavation.

F. If foundation soils are disturbed or loosened by the upward seepage of water or an uncontrolled flow of water, the affected areas shall be excavated and replaced as indicated.

G. Flotation of structures and facilities shall be prevented by maintaining a positive and continuous removal of water sufficient to reduce groundwater to the specified level.

H. If well points or wells are used, they shall be adequately spaced to provide the necessary dewatering and sand packing and/or other means shall be used to prevent pumping of fine sands or silts from the subsurface. A continuous check shall be maintained to ensure that the subsurface soil is not being removed by the dewatering operation.

I. No water shall be drained into work built or under construction. Before disposal, water shall be treated in accordance with permit requirements. Following dewatering, groundwater shall be allowed to return to its original level in a manner that avoids disturbance of natural foundation soils, prevents disturbance of compacted backfill, and prevents flotation or movement of structures.

END OF SECTION

SECTION 02231

AGGREGATE BASE AND SUBBASE

PART 1 GENERAL

1.1 SUBMITTALS

A. At least 10 working days prior to the use thereof, the Contractor shall submit a 120-pound sample of aggregate, graded as intended for use and testing report for review. This requirement shall be complied with for each aggregate and grading thereof that has not been approved. The Owner may choose to perform its own test on the sample, at no cost to the Contractor, to verify and determine the acceptability of the aggregate.

PART 2 PRODUCTS

2.1 FILL MATERIALS BASE

A. The aggregate shall be free from vegetable matter and other deleterious substances. Aggregate for aggregate base shall be classified Caltrans Class 2. The percentage composition by weight of aggregate base shall conform to ¾" maximum grading when determined by Test Method No. Calif. 202.

1. Unless otherwise specified, the aggregate base size distribution shall be in accordance with the grading specified for ¾ inch maximum

AGGREGATE GRADING REQUIREMENTS

Sieve Sizes	Percentage Passing			
	1½" Maximum		¾" Maximum	
	Operating Range	Contract Compliance	Operating Range	Contract Compliance
2"	100	100	–	–
1½"	90-100	87-100	–	–
1"	–	–	100	100
¾"	50-85	45-90	90-100	87-100
No. 4	25-45	20-50	35-60	30-65
No. 30	10-25	6-29	10-30	5-35
No. 200	2-9	0-12	2-9	0-12

B. The aggregate base shall also conform to the following quality requirements:

QUALITY REQUIREMENTS

Test	Test Method No. California	Operating Range	Contract Compliance
Resistance (R-value)*	301	–	78 Min.
Sand Equivalent	217	25 Min.	22 Min.
Durability Index	229	–	35 Min.

* The R-value requirement will be waived provided the aggregate base conforms to the specified grading and durability and has a sand equivalent value of 35 or more.

C. The aggregate shall not be treated with lime, cement or other chemicals before the Durability Index test is performed.
   1. Material yielding a maximum dry density of less than 112 pounds per cubic foot when tested in the laboratory in accordance with ASTM D1557 "Standard Methods of Test for Moisture-Density Relations of Soils, Using 10-pound Rammer and 18-inch Drop,"shall not be used.
   2. Any rock, including red rock, meeting all the requirements of this Section will be acceptable. Such rock shall be plant processed at a processing plant approved by the Owner.

D. Contractor shall perform all tests as required by this specification.

2.2 FILL MATERIALS - SUBBASE

A. The aggregate shall be free from vegetable matter and other deleterious substances. Aggregate for subbase shall be Caltrans classified Class 3 with R-valve of no less than 40.
   1. Unless otherwise specified, the particle size distribution shall be in accordance with the grading specified for 3-inch maximum size aggregate.

Sieve Sizes	Percentage Passing 3" Maximum
3"	100
2-1/2"	87-100
No. 4	45-100
No. 200	0-34

   2. The subbase shall have a relative compaction ratio of 95%.

PART 3 EXECUTION

3.1 SPREADING

A. Aggregate base material shall be delivered to the roadbed as uniform mixtures and each layer shall be spread in one operation.

B. At the time aggregate base is spread it shall have a moisture content sufficient to obtain the required compaction. Such moisture shall be uniformly distributed throughout the material. The material shall be spread upon the subgrade prepared by means of vehicles equipped with approved spreading devices at a uniform quantity per linear foot, which quantity will provide the required compacted thickness within the tolerances specified. Depositing and spreading shall commence at that part of the work farthest from the supply of base material and shall progress continuously without breaks, unless otherwise directed by the Owner.

C. Where the required thickness is 6 inches or less, the base material may be spread and compacted in one layer. Where the required thickness is more than 6 inches, the base material shall be spread and compacted in 2 or more layers of approximately equal thickness, and the maximum compacted thickness of any one layer shall not exceed 6 inches. Each layer shall be spread and compacted in a similar manner. Base material placed in areas inaccessible to the spreading equipment, may be spread in one or more layers by any means that will make possible the specified compaction and surface. When the subgrade for aggregate base consists of cohesionless sand and written permission is granted by the Owner, the base material may be dumped in piles upon the subgrade and spread ahead from the dumped material.

D. The base material, after spreading, shall be shaped by means of a blade grader to such thickness that after watering and compacting, the completed base will conform to the required grade and cross section within the tolerances specified. Segregation of aggregate shall be avoided and the base shall be free from pockets of coarse or fine material.

3.2 COMPACTING

A. Immediately following spreading, shaping and smoothing, the full width of the base material shall be watered as ordered by the Owner, and compacted by rolling with a minimum of two self-propelled reversible equipment specified as follows:
   1. For initial rolling use a 3 wheel steel-tired roller, weighing not less than 12 tons distributed so that the rear wheels will apply to the surface being rolled not less than 325 pounds per linear inch of rear tire width. Rolling shall commence by covering completely the outer edge of the material. Subsequent passes shall lap at least 25 percent on previously rolled material.
   2. For subsequent rollings use a pneumatic-tired roller of the oscillating type, having a width of not less than 4 feet and equipped with tires of equal size and diameter. Wobble wheel rollers will not be permitted. The tires shall be so spaced that the entire gap between adjacent tires will be covered by the tread of the following tire. The tires shall be inflated to 90 pounds per square inch minimum.
   3. To compact all areas inaccessible to the rollers, use compressed air, or gas, powered tampers.

B. The foregoing equipment requirements serve as a standard of adequacy.
   1. Subject to the condition that the Contractor shall notify the Owner at least 10 days in advance, and shall secure approval for the use of each piece of compacting equipment other than that specified, selection thereof and obtainment of the specified compaction throughout the volume of base and the specified surface, shall be solely the responsibility of the Contractor.
   2. If compaction is not uniform or tests show it to be inadequate, or if the surface is unsatisfactory, the Owner may require the use of other or additional equipment.
   3. Should low or high spots develop during rolling operations, such spots shall be smoothed out by blading with a self-propelled and pneumatic-tired motor grader having a wheelbase not less than 15 feet long and a blade not less than 10 feet long.

C. Aggregate base shall be watered after compaction. Water shall be applied at the rate and in the quantities proposed by the Contractor and accepted by the Owner.
   1. The relative compaction of aggregate base, determined by tests of the in place, field compacted base shall be not less than 95 percent of the maximum compaction at optimum moisture content determined by ASTM D 1556 and Method C of ASTM D 1557.
   2. The surface of the finished aggregate base at any point shall not vary more than 0.05 foot above or below proper grade and such surface shall contain no ridges, valleys or sharp breaks.
   3. Finished base that does not conform to the foregoing requirement shall be reshaped or reworked, watered and thoroughly re-compacted to conform thereto.
   4. The Contractor shall not allow any completed untreated rock base to be subjected to public or construction traffic, except the latter necessary to the completion of the overlying surface course.

END OF SECTION

SECTION 02256

PROTECTIVE SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Protective Systems
      a. Shoring
      b. Trench plating
      c. Public safety
B. Related Sections:
   1. Section 02320 Trenching, Backfilling, and Compacting

1.2 SUBMITTALS

A. Shop Drawings:
   1. General:
      a. Include supporting calculations for all proposed protective systems. Include all details, arrangements, and the methods of installation, as applicable.
         1) Describe method of installation and removal of all protective systems, including the sequencing of specific components as related to excavation, construction and backfilling operations.
   2. Shoring systems:
      a. Indicate depth of excavation at which support system will be installed.
      b. Show in the calculations the full excavation depth load to be carried by various members of the support system. Include design loads and calculated deflections of shoring and support members.
B. Quality Assurance/Control Submittals
   1. Submittals shall be stamped and signed by a California licensed civil or structural engineer.

1.3 DEFINITIONS

A. For the purposes of this Section 02256, shoring or shoring system shall mean shoring, sheeting, shielding, sloping, bracing, or equivalent provisions and protective systems for protection from the hazard of caving ground in open trenches and other excavations.

1.4 SYSTEM DESCRIPTION

A. Design Requirements:
   1. Comply with CCR Title 8, Division 1, Chapter 4, subchapter 4 (Construction Safety Orders), Section 1541.1
   2. Support earth and rock pressure, unrelieved hydrostatic pressures, utility loads, equipment, applicable traffic and construction loads, and other surcharge loads.
   3. Support the maximum loads that can occur during construction.
B. Performance Requirements:
   1. Shoring systems:
      a. Provide a safe and stable excavation without lateral or vertical movement or settlement of the ground.
      b. Prevent damage to or movement of adjacent structures and utilities.

2. Trench plating: Provide for safe vehicular travel across trenches and other excavations.
3. Public Safety: the project area is open to public access for recreation. Contractor shall provide for the public to safely use the project areas during working and non-working hours, including but not limited to protecting all excavations.

1.5 PROJECT CONDITIONS

A. Project Requirements
1. If existing utilities interfere with proposed method of support, modify the support system at Contractor's expense.
2. Contractor shall be aware that steep slopes/embankments may be present at the Project Site.

PART 2 PRODUCTS

2.1 MATERIALS

A. All materials used for the protective systems, whether new or used, shall be sound and free from defects that may impair their strength.

PART 3 EXECUTION

3.1 GENERAL

A. Install, maintain, and remove protective systems in accordance with submitted plans and all other applicable requirements.
B. Shoring Systems:
1. Proceed with caution in areas where utilities are within the shoring and excavation prism. Expose utilities by hand excavation.
2. Maintain bracing support members in tight contact with each other and with the surface being supported.
3. Remove sheet piling and other shoring in such a manner as to prevent caving at the walls of excavations or damage to piping, structures or other improvements.
4. Immediately fill all voids created by the removal of the supporting system with well-graded cohesionless sand, lean concrete, or sand cement grout.
5. Remove shoring as backfilling progresses but only when banks are stable and safe from caving or collapse.
6. Unless otherwise approved by Owner, no sheeting shall be left in a trench and no backfill shall be made against the sheeting before it is removed. If sheeting extends below the invert of the pipe and is approved by Owner to be left in place, the upper portion shall be removed by trimming in a manner satisfactory to the Owner.

END OF SECTION

SECTION 02320

TRENCHING, BACKFILLING, AND COMPACTING FOR UTILITIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Excavation, trenching, backfilling, and compacting for facilities, including:
      a. Water piping
      b. Electrical duct banks and conduits
      c. Drain piping
      d. All related utility appurtenances
   2. Structure bedding and backfill for concrete utility structures
   3. Grading

B. Related Sections:
   1. Section 02231 Aggregate Base
   2. Section 02256 Protective Systems
   3. Section 02510 Asphalt Concrete Paving

1.2 REFERENCES

A. ASTM D 6024	Standard Test Method for Ball Drop on Controlled Low Strength Material to Determine Suitability for Load Application
B. California Test Method 202	Sieve Analysis of Fine and Coarse Aggregates
C. California Test Method 204	Plasticity Index of Soils
D. California Test Method 216	Relative Compaction of Untreated and Treated Soils and Aggregates
E. California Test Method 217	Sand Equivalent
F. California Test Method 229	Durability Index
G. California Test Method 231	Relative Compaction of Untreated/Treated Soils and Aggregates (Area Concept Utilizing Nuclear Gauges)
H. Caltrans 26-1.02A	Standard Specifications Section 26, Class 2 Aggregate Base
I. Greenbook	Standard Specifications for Public Works Construction, latest version

1.3 SUBMITTALS

A. Product Data:
   1. Imported materials, include source, testing, inspection, sieve analysis, and other pertinent data
   2. Select bedding or select backfill material, include testing, inspection, sieve analysis, specific location of Samples tested, stockpile or stationing information, date, and other pertinent data
   3. Geotextile fabrics
   4. Controlled Low Strength Material (CLSM) mix design

B. Samples:
   1. One-pound bag of imported bedding material, excluding CLSM.

2. Geotextile fabrics, one 6 inch by 6 inch Sample of each type

C. Quality Assurance/Control Submittals:
1. Test Reports:
   a. Mix design for CLSM, water-cement -fly ash ratio curves, mix ingredients and proportions, and admixtures.
2. Manufacturer's Instructions:
   a. Pipe and conduit manufacturer's instructions regarding trenching, methods of installation, and general recommendations

PART 2 PRODUCTS

2.1 MATERIALS

A. Bedding Material (Pipe and Conduit Bedding):
1. Imported Material:
   a. Granular material (sand, gravel, crushed aggregate).
   b. Sand equivalent not less than 30.
   c. Gradation conforming to the following:

Size	**Percent Passing (by dry weight)**
1/2 inch	100
3/8 inch	90-100
#4	35-45
#30	0-10
#200	0-3

2. Local Material (approved select material excavated from the Site):
   a. Granular material (sand, gravel).
   b. Sand equivalent not less than 30.
   c. Conforming to the requirements for imported bedding, unless otherwise approved by Owner.
   d. Approved for use as bedding material by Owner prior to use.
3. CLSM:
   a. Conform to Greenbook 201 for CLSM
   b. Designed compressive strength: between 75 and 150 psi at 28 Days
   c. Slump: 8 inches ± 2 inches
   d. Maximum aggregate size: 3/8 inch
      1) Comprising no more than 30% of total aggregate
   e. Percent passing No. 200 sieve: 12% maximum
   f. Sand equivalent: 20 minimum
   g. Fly ash: 300 lb/cy maximum
   h. Portland cement:
      1) 50-200 lb/cy
      2) percent air in mix: 25% maximum

i. Consistency shall allow mix to flow into all voids and around all pipes, appurtenances, and structures.

B. Backfill Material (Pipe and Conduit Trenches):
1. Imported Material:
a. Clean soil, free from organic material, trash, debris, rubbish, broken concrete, bituminous materials, or other objectionable substances.
b. Sand equivalent not less than 20.
c. Gradation conforming to the following:

Size	Percent Passing (by dry weight)
4 inch	100
#4	35-100
#30	20-100

2. Local Material (approved select material excavated from the Site):
a. Clean soil, free from organic material, trash, debris, rubbish, broken concrete, bituminous materials, or other objectionable substances.
b. No rocks larger than 4 inch.
3. CLSM: same as for Bedding Material above.

C. Foundation Material (Pipe and Conduit Trenches):
1. Imported crushed rock.
2. Free draining.
3. Minimum Durability Index not less than 40.
4. Gradation conforming to the following:

Size	Percent Passing (by dry weight)
1 inch	100
3/4 inch	82-100
1/2 inch	10-35
3/8 inch	0-10
#4	0-3
#8	0-1

D. Trench Surfacing Material:
1. Asphaltic concrete:
a. Per Caltrans Standard Specifications and Special Provisions
2. Aggregate Base:
a. Per Caltrans Standard Specifications and Special Provisions
3. Local Material (excavated from the Site):
a. As specified in paragraph 2.1B.2 of this Section 02320.

4. Stripped Topsoil (stripped from the Site):
   a. Material stripped as per Caltrans Standard Specifications and Special Provisions
   b. Soil material excavated from the top 12 inches of native ground and stockpiled for re-use as trench surfacing material.
   c. Free from trash, debris, rubbish, broken concrete, bituminous materials, or other objectionable substances.

E. Structure Bedding and Backfill Material:
1. Structure Bedding Material:
   a. Imported crushed rock
   b. Free draining
   c. Minimum Durability Index not less than 40
   d. Gradation conforming to the following:

Size	Percent Passing (by dry weight)
1 inch	100
3/4 inch	82-100
1/2 inch	10-35
3/8 inch	0-10
#4	0-3
#8	0-1

2. Structure Backfill Material:
   a. Imported or select material excavated from the Site conforming to the following:
      1) Clean soil, free from organic material, trash, debris, rubbish, broken concrete, bituminous materials, or other objectionable substances.
      2) Sand equivalent not less than 20.
      3) Low expansion potential.
      4) Plasticity index less than or equal to 15 percent per Cal Trans Test Method 204.
      5) Liquid limit less than or equal to 40 percent per Cal Trans Test Method 204.
      6) Gradation conforming to the following:

Size	Percent Passing (by dry weight)
3 inch	100
#4	35-100
#30	20-100

F. Geotextile Fabric:
1. Filter Fabric:
   a. Conforming to Caltrans 26-1.02A.
   b. For use with bedding material, as indicated

2. Stabilization Fabric - For use with foundation material:
   a. Manufacturers:
      1) Mirafi 600X
      2) Synthetic Industries 315 ST
      3) Or Approved Equal

PART 3 EXECUTION

3.1 GENERAL

A. Remove and dispose of unsuitable materials as determined by Owner to a site provided by Contractor.

3.2 EXCAVATION

A. Trench Excavation:
   1. Before excavation is started for any run of underground piping, locate and expose all existing structures, piping, conduit, etc., which intersect the line of the piping, to avoid possible damage to these during excavation operations and so that it may be determined if there will be any conflicts in location.
   2. Excavate the top 12 inches of native ground and stockpile for re-use as trench surfacing material.
   3. Excavate trenches by open cut method to depth indicated and necessary to accommodate Work.
   4. Minimum trench width shall be as indicated. Actual trench width shall be sufficient to obtain the required compaction around the pipe or conduit.
   5. Excavate only the amount of trench that can be backfilled the same Day. If trenches must remain open overnight, provide steel trench plates to cover the trenches and prevent a falling hazard to people and wildlife.
   6. As determined by Owner, the maximum allowable length of open trench may be adjusted based upon weather or other Site conditions encountered during construction.
   7. Any trench or portion of trench, which is opened and remains idle for 7 Days, or longer, as determined by Owner, may be directed to be immediately refilled, without completion of Work, at no additional cost to Owner.
   8. Excavate trenches as necessary to comply with the Drawings and Specifications, to accomplish the specified Work, and to conform to all safety and permit requirements. Do not overexcavate trenches beyond these requirements, unless approved by Owner.
   9. Excavate as needed to facilitate removal of handling devices after the pipe is laid. Form bell (joint) holes at the ends of the pipe to prevent point loading at the bells or couplings and to facilitate welding, bolting, grouting, visual inspection, and other required field operations for pipe installation. Excavate as needed outside the normal trench section at joints, appurtenances, and connections to existing pipes, sufficient to provide adequate access for welding, bolting, grouting, visual inspection, and other required field operations for pipe installation.
   10. Grade the bottom of the trench to the line and grade to which the pipe is to be laid, with proper allowance for pipe thickness and for bedding material. Remove hard spots that would prevent a uniform thickness of bedding. Before laying each section of the pipe, check the grade and correct any irregularities found. The trench bed shall form a continuous and uniform bearing and support for the pipe at every point between bell holes, except the grade may be disturbed for the removal of lifting tackle.

11. Avoid overloading or surcharge a sufficient distance back from edge of excavation to prevent slides or caving.

B. Excavation for Structures:
   1. Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, for compacting structure backfill material, and for inspections.
      a. Do not disturb bottom of excavation. Trim bottoms to required lines and grades to leave solid base to receive other Work.
      b. Level off bottoms of excavations. Remove loose materials and bring excavations into approved condition.
      c. Do not carry excavations lower than shown except as directed by Owner.
      d. Notify Owner as soon as excavation is completed in order that subgrades may be inspected. Do not commence further construction until subgrade has been inspected and approved by Owner as being free of undesirable material, being of compaction density required by this Specification, and being capable of supporting the design bearing pressures and loads to be placed thereon.

3.3 PREPARATION OF FOUNDATION FOR PIPE LAYING

A. In the Event of Over-Excavation:
   1. Backfill and compact over-excavated material to 90 percent of maximum dry density.
   2. Alternately, backfill with granular fill material, as approved by Owner.

B. Subgrade Stabilization:
   1. Stabilize the subgrade when directed by Owner.
   2. Stabilize unstable subgrade that occurs as a result of Contractor's failure to sufficiently dewater or other Contractor operations, as directed by Owner with no additional compensation.

3.4 BEDDING METHODS: PIPE AND CONDUIT TRENCHES

A. Remove rocks or boulders that protrude into the embedment zone, fill voids with bedding material, and compact to the specified bedding density, with no additional compensation.
B. Place bedding material on firm unyielding subgrade so that pipe or conduit is supported for the full length of the barrel.
C. Where subgrade stabilization is required, install geotextile fabric (stabilization fabric) between bedding and foundation materials.
D. Where granular bedding is used (versus CLSM), lay pipe directly on the bedding material. No blocking will be permitted, and the bedding shall be such that it forms a continuous, solid bearing for the full length of the pipe.
E. After the pipe and pipe joint are properly positioned in the trench, bed the length of pipe between the joints to at least one foot above the top of the pipe. Exercise care during the initial bedding to prevent movement of the pipe and to prevent any bedding material from being deposited on the joints.
F. Place and compact bedding material in compliance with Greenbook 306-1.3.2.
G. Place bedding material in lift thicknesses capable of being compacted to specified densities, but not exceeding the thickness allowed by Greenbook 306-1.3.2.
H. Compact each lift to specified requirements.
I. Avoid displacing joints and appurtenances or causing any horizontal or vertical misalignment, separation, or distortion.

J. If Owner determines that it is not practical to attain the required compaction by mechanical methods, CLSM bedding material shall be required.
K. Water flushing or jetting for consolidation (compaction) is not permitted.
L. Where CLSM bedding material is used, place bedding in a manner to avoid flotation of the pipe. Prior to CLSM bedding placement, place and support pipe within the trench in an Owner-approved manner. Avoid excessive stress or deflection of the pipe, as determined by the Owner. Pipe may be supported with isolated mounds of granular bedding material prior to CLSM bedding placement, as approved by Owner. CLSM placed in an area to receive subsequent soil backfill shall achieve a maximum indentation diameter of 3 inches per ASTM D 6024 prior to backfilling.

3.5 BACKFILLING METHODS: PIPE AND CONDUIT TRENCHES

A. Backfill trenches to original grade, unless otherwise indicated.
B. Remove rocks or boulders that protrude into the backfill zone, fill voids with backfill material, and compact to the specified backfill density with no additional compensation.
C. Backfill as soon as possible. However, do not place backfill material until all necessary inspections and tests (that are required to be performed on pipe or conduit prior to backfilling) are completed and demonstrate compliance to specified requirements.
D. Place backfill material on fully compacted bedding material.
E. Install geotextile fabric (filter fabric) between bedding and backfill materials, unless CLSM bedding or backfill is used.
F. Where rocks are included in the backfill, mix with suitable excavated materials to eliminate voids.
G. Perform placement and compaction of backfill material in compliance with Greenbook 306-1.3.2.
H. Place backfill material in lift thicknesses capable of being compacted to specified densities, but not exceeding the thickness allowed by Greenbook 306-1.3.2.
I. Compact each lift to specified requirements.
J. Avoid displacing joints and appurtenances or causing any horizontal or vertical misalignment, separation, or distortion.
K. If Owner determines that it is not practical to attain the required compaction by mechanical methods, CLSM backfill material shall be required.
L. Process excavated (native) backfill material when necessary to achieve the specified compaction requirements.
M. Water flushing or jetting for consolidation (compaction) is not permitted.
N. For topsoil backfill, replace stockpiled stripping (topsoil) material from pipeline trench areas back into the top 12 inches of the trench and in generally the same area from which the material was removed. Moisture condition and compact to 80 percent relative compaction. Scarify and re-compact areas compacted to more than 85 percent relative compaction.
O. CLSM placed as backfill in areas to be paved or receive subsequent soil backfill shall achieve a maximum indentation diameter of 3 inches per ASTM D 6024, prior to paving or backfilling.

3.6 STRUCTURE BEDDING AND BACKFILL

A. General:
   1. Subgrade to receive structure bedding or backfill shall be free of undesirable material as determined by Owner and scarified to a depth of 6 inches and compacted to 95% relative density per California Test Method 216. Do not place any bedding or backfill material

until subgrade under bedding or backfill has been inspected and approved by Owner as being free of undesirable material and compacted to specified density.

2. Obtain approval of backfill material from Owner prior to placing the material.
3. Place all equipment support slabs and utility vaults and boxes on a minimum of 6 inches of structure bedding material that is spread over the entire bottom area of the structure excavation, unless otherwise indicated.
4. Compact bedding to form a firm unyielding structural base.
5. Place and compact backfill material in thin lifts (4" uncompacted, maximum) as necessary to obtain required compaction density. Compact material by means of equipment of sufficient size and proper type to obtain specified density. Use hand operated equipment for backfilling next to walls.
6. In all roads and in paved areas, compact structure backfill to 90 percent relative density (California Test Method 216) for material more than 3 feet below finished grade and to 95 percent relative density (California Test Method 216) for material within 3 feet of finished grade.
7. In all other areas (unpaved) compact structure backfill to 90 percent relative density (California Test Method 216).

3.7 GRADING

A. Uniformly grade areas to a smooth surface, free from irregular surface changes.
   1. Provide a smooth transition between adjacent existing grades and new grades.
   2. Cut out soft spots, fill low spots, and trim high spots as required.

B. Finishing: Dress and grade slopes to provide a uniform surface and slopes that conform smoothly to contours or grades indicated. Embankment slopes shall be overfilled and then trimmed back to a dense, uniform surface at the final grade. Soil shall not be spilled over the slope face nor shall slopes be pushed out to obtain grades. Finish grade all other disturbed areas to a uniform surface and to drain.

3.8 MOISTURE CONTROL

A. Uniformly moisten or aerate each fill or backfill layer before compaction to within 2 percent of optimum moisture content, as determined by California Test Method 216. Unless otherwise approved by Owner, fill materials shall be moisture conditioned and mixed prior to placement.
   1. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
   2. Remove and replace, or scarify and air-dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent or more and is too wet to compact to specified dry unit weight.

B. Manipulate embankment materials by harrowing or other approved methods as necessary to achieve uniform moisture content within the limits stated above. Supplement, as required, by sprinkling water on the embankment fill.

C. Treat top or contact surfaces of the embankment sections which become too smooth or dry to suitably bond with succeeding layers by moistening and/or working with a harrow, scarifier, or other suitable equipment to the depth and in the manner directed by Owner.

3.9 FIELD QUALITY CONTROL

A. Testing:
   1. Owner will perform in-place moisture-density tests after receiving written request from Contractor.

2. Testing will be performed in accordance with the following:
   a. Gradation: California Test Method 202
   b. Density: California Test Method 216 and California Test Method 231
   c. Sand Equivalent: California Test Method 217
   d. Durability Index: California Test 229
3. Additional tests will be performed until compaction meets or exceeds requirements.
4. Ensure Owner has immediate access for testing of all soils-related Work.
5. Ensure excavations are safe for testing personnel.

END OF SECTION

SECTION 02375

HYDROSEED AND EROSION CONTROL BLANKET

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Erosion and sediment control measures to prevent erosion and sediment pollution into streams and waterways due to construction.

1.2 SUBMITTALS

A. Product Data:
   1. Seed
   2. Fertilizer
   3. Mulch
   4. Stabilizer
   5. Erosion Control Blanket
B. Hydroseed mix design
C. Samples:
   1. 6-inch x 6-inch Sample of erosion control blanket
D. Quality Assurance/Control Submittals:
   1. Manufacturers' instructions
      a. Erosion control blanket installation and details

1.3 PROJECT CONDITIONS

A. Project Environmental Requirements:
   1. Weather conditions: Hydroseeding shall not be permitted when wind velocities exceed 15 miles per hour, when the ground is frozen, or within 24 hours after a rain.

1.4 SCHEDULING

A. The hydroseeding shall be in place within 10 Days after completion of finish grading and no later than November 1 following completion of finish grading.
B. Prior to hydroseeding, finish grading shall be complete.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Erosion Control Blanket
   1. North American Green, C125
   2. American Excelsior Company, Curlex I
   3. Or Approved Equal
B. Materials
   1. Seed:
      a. All seed that is required for this Project must be labeled under the California Food and Agriculture Code and shall be labeled by the vendor(s) supplying seed.
      b. The following blend of seed shall be used for all surfaces:

Name	Pounds per acre
Red Fescue *(Festuca rubra)*	10
Creeping Wild Rye *(Leymus triticoides)*	10
Meadow Barley *(Hordeum brachyantherum)*	25
"Hykon" Rose Clover *(Trifolium hirtum 'Hykon')*	10

2. Maximum allowable weed seed content in seed mix is 0.5%.
3. Mulch: a fibrous cellulose mulch, containing no growth or germination inhibiting substances, and shall be manufactured in such manner that when thoroughly mixed with seed, fertilizer, organic stabilizer, and water, in the proportions specified, it will form a homogeneous slurry which is capable of being sprayed to form a porous mat. The fibrous mulch in its air-dry state shall contain not more than 10 percent by weight of water. Apply at a rate of 2,000 pounds per acre.
4. Stabilizer: an organic soil binder derived from *Plantago insularis*. Apply at a rate of 100 pounds per acre.
5. Water: Clean and free of deleterious materials. Reclaimed or recycled water shall not be used.
6. Fertilizer: Water soluble with a nitrogen-phosphorus-potassium ratio of 16-20-0. Apply at a rate of 300 pounds per acre.

C. Warranty
1. Seeded areas not producing the required 75% cover of native herbaceous vegetation within 3 months of the seeding operations shall be prepared, reseeded and maintained with the same seed mix and as per the original specification at no additional expense to the Owner.

PART 3 EXECUTION

3.1 HYDROSEED AREAS

A. Hydroseed all disturbed, unpaved ground surfaces and slopes steeper than 10 percent (10 horizontal to 1 vertical).

3.2 SURFACE PREPARATION

A. Per the hydroseed manufacturer/applicator recommendations.
B. Remove all construction debris and weeds/grasses from areas to be hydroseeded.

3.3 HYDROSEED MIXTURE APPLICATION

A. Owner shall be present for the initial mixing and application of the hydroseed mix.
B. Combine water, seed, fertilizer, mulch, and stabilizer into a homogenous slurry, capable of being sprayed by application equipment.
1. Fill mixing tank with water sufficient to reach the level of the main agitator shaft.
2. Start mixing agitators and regulate throttle throughout the loading process to achieve vigorous agitation.
3. Load machine with stabilizer, mulch, seed, fertilizer, and the balance of the required water. Load stabilizer through a bale breaker or break by hand.

4. Vigorously agitate the mixture for a minimum of ten minutes after loading to allow thickening. Perform "free liquid" test to ensure suitability of mixture for Owner. Reduce agitation to a minimum.
5. Apply mixture in even layers, working back and forth to uniformly cover soil with the mixture. Spray the finished product through a fan or slit-type nozzle to create a fine uniformly dispersed spray that 'rains down' on the soil.

3.4 EROSION CONTROL BLANKET INSTALLATION

A. Install:
   1. After hydroseeding
   2. Where indicated
   3. In accordance with manufacturer's recommendations

END OF SECTION

SECTION 02510

ASPHALT CONCRETE PAVING

PART 1 GENERAL

1.1 SUMMARY

A. The Contractor shall provide asphalt concrete pavement structural section as indicated on the Drawings, above the pavement subgrade in accordance with the Contract Documents.

1.2 RELATED SECTIONS

A. Section 02231 (Aggregate Base)

1.3 REFERENCES

A. Standards listed below apply to this section. Where the applicable year of adoption or revision is not listed below, the latest edition applies.
B. Caltrans "Standard Specifications" (CSS).
C. Caltrans, "Manual of Test".
   1. Test 304 - Method of Preparation of Bituminous Mixtures for Testing.
   2. Test 367 - Method for Recommending Optimum Bitumen Content.
D. American Society for Testing and Materials (ASTM):
   1. D 244 - Emulsified Asphalts.
   2. D 402 - Distillation of Cut-Back Asphaltic (Bituminous) Products.
   3. D 1188 - Bulk Specific Gravity of and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens.
   4. D 2950 - Density of Bituminous Concrete in Place by Nuclear Method.

1.4 SUBMITTALS

A. Submit the following:
   1. Certificates of compliance with specified standards for natural materials and manufactured items.
   2. For manufactured items, the manufacturer's technical data of the product of physical properties.

1.5 ASPHALT CONCRETE MIX DESIGN INCLUDING CALIFORNIA TEST 367 RESULTS INDICATING OPTIMUM BITUMEN CONTENT, VOID CONTENT AND MAXIMUM DENSITY. DEFINITIONS

A. Pavement Subgrade: The material in excavation or embankments underlying the lowest layer of subbase, base, pavement surfacing or other specified layer which is to be placed. The surface upon which embankment is to be placed is sometimes called "subgrade" in other sections, not to be confused with pavement subgrade.
B. Structural Section: The planned traffic support layers of specified materials, normally consisting of base and pavement placed over the pavement subgrade. The structural section is also commonly called the pavement structural section.
C. Surface Course: The top layer of AC pavement. The top layer of AC pavement is sometimes called the "wearing course."

1.6 QUALITY CONTROL

A. Comply with all requirements of the Air Pollution Control District, including, but not limited to:
   1. Use no rapid-curing liquid asphalt or rapid setting emulsified asphalt on this project.
   2. Use no medium-curing liquid asphalt on this project unless specifically authorized by the local District. Present proof of authorization.
   3. Use no slow-curing liquid asphalt on this project which contains more than 0.5% by volume of petroleum solvents which evaporate at less than 260 degrees C (500 degrees F) as determined by ASTM D402.
   4. Use no emulsified asphalt on this project containing petroleum solvents in excess of 3% by volume which evaporate at less than 260 degrees C (500 degrees F) as determined by ASTM D244.
   5. Medium-curing liquid asphalt may be used when the National Weather Service forecasts that atmospheric temperature for the 24-hour period following application will not exceed 50 degrees F. Maintain records proving occurrence of this condition, and verify that local jurisdiction approves this exception.
   6. Certain jurisdictions may allow use of the above prohibited products under certain conditions. Prior to use, submit proof of such allowance.

1.7 SITE CONDITIONS

A. Do not place asphalt concrete unless atmospheric temperature is at least 50 degrees Fahrenheit and rising.

PART 2 PRODUCTS

2.1 MATERIALS

A. General: Materials specified below, to be included in the work, are detailed on the Drawings or are indicated in these specifications.

B. Aggregates:
   1. Asphalt Concrete (AC): Type B, 1/2-inch maximum size, medium grading, CSS Section 39.

AGGREGATE GRADING REQUIREMENTS
Type B Asphalt Concrete
Percentage Passing
1/2 inch Maximum, Medium

Sieve Sizes	Limits of Proposed Compliance	Operating Range	Contract Compliance
3/4"	---	100	100
1/2"	---	95-100	89-100
3/8"	---	80-95	75-100
No. 4	59-66	X±5	X±8
No. 8	43-49	X±5	X±8
No. 30	22-27	X±5	X±8
No. 200	---	3-8	0-11

2. Aggregate Base (AB): Class 2, 3/4-inch size, CSS Section 26. Virgin rock only.

Sieve Sizes	Percentage Passing 3/4" Maximum	
	Operating Range	Contract Compliance
2"	–	–
11/2"	–	–
1"	100	100
3/4"	90-100	87-100
No. 4	35-60	30-65
No. 30	10-30	5-35
No. 200	2-9	0-12

QUALITY REQUIREMENTS

Test	Operating Range	Contract Compliance
Resistance (R-value)	–	78 Min.
Sand Equivalent	25 Min.	22 Min.
Durability Index	–	35 Min.

3. Asphalt Binder: Steam-refined paving asphalt, CSS Section 92 Grade AR-4000.
4. Prime Coat: Liquid asphalt, Grade SC-70, CSS Section 93.
5. Paint Binder or Tack Coat: Type SS1h or SS1 asphaltic emulsion, CSS Section 94, subject to limitations of paragraph 1.06.

C. Prime Coat:
1. The rolled surface of the base material shall be primed with liquid asphalt prime coat, Grade SC-70, applied at a uniform rate of 0.25 gallons per square yard. Application shall conform to the requirements of CSS Section 39,.

D. Tack Coat or Binder:
1. A tack coat or paint binder shall be SS-1 asphalt emulsion in conformance with CSS Section 39.

E. Fine Asphalt Concrete Patch Paving:
1. Fine asphalt concrete for patch paving shall be Type B, 3/8" maximum size. The asphalt binder shall be paving asphalt Grade AR-4000 in conformance with CSS Section 92.

2.2 MIXES

A. Asphalt Concrete:
1. CSS Section 39, Type B asphalt concrete.
2. Contractor shall determine the optimum amount of asphalt binder in accordance with the mix design prepared in accordance with California Test 367.

B. Do not change sources from those used in mix designs without prior written approval by Owner.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas to receive asphalt concrete paving and verify the following:
   1. That abutting improvements have been set at proper elevations.
   2. That gradients and elevations of pavement subgrade are correct.
   3. That the condition of the pavement subgrade has been approved by the Owner.
   4. Absence of wet receiving surfaces and other conditions that adversely affect execution of this Work.

B. Do not start Work until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. If after initial preparation, the pavement subgrade is allowed to stand or is used by construction equipment, or is otherwise damaged, repair in accordance with CSS 26-1.03 at no additional cost to the Owner.

B. Protect existing Work from damage. Protect concrete Work from staining with asphalt materials. Shield from overspray.

C. Existing Asphalt Paving to receive the new wearing course of asphalt paving shall be thoroughly cleaned of all dirt, water and oil to the satisfaction of the Owner. Cracks 1/8 inch wide or greater shall be cleaned and filled with bituminous material or by a method approved by the Owner. Large cracks, faults or potholes shall be repaired as specified above or shown on the plans.

3.3 AGGREGATE BASE

A. Spread and compact in accordance with CSS Section 26, to thickness, lines and grades noted, with a maximum deviation of plus 0.0 and minus 0.05 feet from plan grade.

B. Do not incorporate into the completed section any base material used for construction traffic.

C. Water the compacted base in accordance with CSS Section 17.

3.4 BASE PRIME COAT

A. After base has been approved by Owner, place asphalt concrete paving on new aggregate base while base is still tight and damp, without prime coat.

B. If base has been allowed to dry before placing asphalt concrete, apply prime coat in amount of 0.25 gallons per square yard of surface area to base in accordance with CSS Section 39, at no additional cost to the OWNER. Allow at least 24 hours for prime coat to set; remove any puddles; and spread sand over damp spots before placing asphalt concrete.

3.5 PAINT BINDER

A. Prior to placing asphalt concrete surfacing, apply a coat of asphaltic emulsion paint binder to all vertical contact surfaces in accordance with CSS Section 39 at an approximate rate of 0.10 gallons per square yard of surface covered.

3.6 ASPHALT CONCRETE

A. After prime coats have been approved by Owner, spread and compact asphalt concrete paving to compacted thickness shown on Drawings in accordance with CSS Section 39, including all requirements for mix temperatures, and thickness of layers.

B. Compact to a density at least 95 percent of that obtained with the California Kneading Compactor, California Test 304.

C. Provide surface which is dense, smooth, tight, free from pores, loose material or segregation, within tolerances specified, and free of bird baths.
D. Finished surface shall be to more than 0.02 feet below the bottom of a 12-foot straightedge laid on the surface in any direction.
E. Place asphalt concrete so that finished surface will be 0-inch to 1/8-inch, above edge of adjacent concrete gutters designed to collect water runoff, or 0-inch to 1/8-inch below edge of adjacent concrete designed to deposit runoff onto paved surface.
F. Carefully roll with proper heat at edges alongside curbs, walks and driveways to match balance of rolled Work. Hand tamping will be permitted only where inaccessible to heavy equipment.
G. Finish rolling before paving temperature has dropped to 150 degrees F.

3.7 FIELD QUALITY CONTROL

A. Contractor shall:
   1. Measure and record temperature of asphalt concrete just prior to paving.
   2. As directed by Owner, remove and replace or repair all paving not meeting Contract Document requirements.
B. After the completion of the inspections and tests performed, the results shall be delivered to Owner within 5 working days.

3.8 PROTECTION

A. Permit no surface traffic until surface has cooled sufficiently to resist damage.

3.9 STRUCTURES

A. Adjust existing and new manholes, meter boxes, catch basins, cleanouts, etc. to match the new grade.

END OF SECTION

DIVISION 3

CONCRETE

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Miscellaneous cast-in-place concrete for:
      a. Collars
      b. Bases
         1) Equipment bases
      c. Footings
         1) Air valve pre-cast structures
         2) Air valve vent poles
         3) Blowoff pre-cast structures
         4) Bollards
         5) Test stations (field installation)
         6) Warning signs
      d. Structure floors
         1) Drain inlets
      e. Anchor blocks
      f. Pipeline markers
   2. Grout
   3. Adhesive anchors

B. Related Sections:
   1. Section 02320 (Trenching, Backfilling, and Compacting for Utilities)
   2. Section 03405 (Precast Concrete Utility Structures)

1.2 REFERENCES

A.	ACI 305R	Hot Weather Concreting
B.	ACI 306R	Cold Weather Concreting
C.	ACI 308	Recommended Practice for Curing Concrete
D.	ACI 309	Recommended Practice for Consolidation of Concrete
E.	ACI 315	Details and Detailing of Concrete Reinforcement
F.	ACI 318	Building Code Requirements for Reinforced Concrete and Commentary
G.	ACI 347R	Guide to Formwork for Concrete
H.	ASTM A615	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
I.	ASTM C33	Standard Specification for Concrete Aggregates
J.	ASTM C94	Standard Specification for Ready-Mixed Concrete
K.	ASTM C150	Standard Specification for Portland Cement
L.	ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
M.	ASTM C531	Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes

N.	ASTM C579	Standard Test Method for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings and Polymer Concretes
O.	ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
P.	ASTM C827	Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures
Q.	ASTM D696	Standard Method for Coefficient of Linear Thermal Expansion of Plastics Between –30° C and 30° C
R.	Greenbook 201-1	Concrete, Mortar, and Related Materials – Portland Cement Concrete
S.	Greenbook 201-1.1.2	Concrete, Mortar, and Related Materials - Concrete Specified by Class and Alternate Class
T.	Greenbook 201-1.2	Concrete, Mortar, and Related Materials - Materials
U.	Greenbook 303-1.7	Concrete and Masonry Construction - Placing Reinforcement
V.	Greenbook 303-1.10	Concrete and Masonry Construction – Curing
W.	NSF/ANSI 61	Drinking Water System Components - Health Effects

1.3 SUBMITTALS

A. Product Data:
   1. Concrete mix designs
   2. Grout
   3. Adhesive anchors
B. Shop Drawings:
   1. Reinforcing steel
C. Quality Assurance/Control Submittals:
   1. Test Reports:
      a. Mill test reports
         1) Reinforcing steel
         2) Cement
      b. Concrete Mix Designs: Trial mixes including water-cement-fly ash ratio curves, concrete mix ingredients and proportions, and admixtures.
D. Delivery Tickets: With each batch of concrete, furnish certified delivery tickets listing information in paragraph 16.1 and 16.2 of ASTM C94.

PART 2 PRODUCTS

2.1 GENERAL

A. Miscellaneous cast-in-place concrete: Class 560-C-3250 in accordance with Greenbook 201-1.1.2.
B. Steel reinforcement: ASTM A615, Grade 60, deformed.

2.2 FORMS

A. Concrete forms shall be lumber, plywood, or other approved material that will not adversely affect the concrete and will facilitate placement of the concrete to the shape, form, line, and grade indicated.

B. Lumber:
   1. Douglas fir or Southern pine, construction grade or better.
   2. Or approved equal

2.3 CONCRETE MATERIALS

A. Portland Cement: ASTM C150 Type II low alkali and conforming to Greenbook 201-1.2.
B. Fly Ash: ASTM C618, Class C or F including supplementary optional requirements relating to reactive aggregates and alkalis.
C. Aggregates:
   1. Natural aggregates shall be free from deleterious coatings, conforming to ASTM C33 and Greenbook 201-1, except as modified herein. Aggregates shall not be potentially reactive as defined in Appendix XI of ASTM C33. Aggregates shall be thoroughly and uniformly washed before use.
   2. Fine aggregate shall be hard, dense, durable particles of either sand or crushed stone regularly graded from coarse to fine. Gradation shall conform to ASTM C33.
   3. Course aggregate shall be:
      a. Natural gravels,
      b. Combination of gravels and crushed gravels,
      c. Crushed stone, or
      d. Combination of these materials, containing no more than 15 percent flat or elongated particles (long dimension more than five times the short dimension). Materials finer than the 200 sieve shall not exceed 0.5 percent.
D. Mixing Water: Fresh, clean, potable and free from oil, acid, alkali, organic matter, or other deleterious substances.
E. Ready-Mixed Concrete shall conform to the requirements of ASTM C94.

2.4 CURING COMPOUND

A. Liquid membrane-forming curing compound shall be clear or translucent, suitable for spray application and shall conform to ASTM C309, Type 1.

2.5 GROUTS

A. Cement Grout:
   1. Cement grout shall be composed of one part cement, two parts sand, and the minimum amount of water necessary to obtain the desired consistency. Where needed to match the color of adjacent concrete, white portland cement shall be blended with regular cement as needed. The minimum compressive strength at 28 Days shall be 4,000 psi.
B. Non-shrink grout:
   1. NSF/ANSI 61 approved for all applications in contact with potable water.
   2. Non-shrink grout shall be a prepackaged, inorganic, non-gas liberating, non-metallic, cement-based grout requiring only the addition of water. Manufacturer's instructions shall be printed on each bag or other container in which the materials are packaged. The specific formulation for each class of non-shrink grout specified herein shall be that recommended by the manufacturer for the particular application.
   3. Class A non-shrink grouts shall have a minimum 28-Day compressive strength of 5000 psi, shall have no shrinkage (0.0 percent) and a maximum 4.0 percent expansion in the plastic state, and shall have no shrinkage (0.0 percent) and a maximum of 0.2 percent expansion in the hardened state.
   4. Class B non-shrink grouts shall have a minimum 28-Day compressive strength of 5000 psi.

C. Epoxy Grout:
   1. NSF/ANSI 61 approved for all applications in contact with potable water.
   2. Epoxy grout shall be a pourable, non-shrink, 100 percent solids system. The epoxy grout system shall have three components: resin, hardener, and specially blended aggregate, all pre-measured and prepackaged. The resin component shall not contain any non-reactive diluents. Resins containing butyl glycidyl ether or other highly volatile and hazardous reactive diluents are not acceptable. Variation of component ratios is not permitted unless specifically recommended by the manufacturer. Manufacturer's instructions shall be printed on each container in which the materials are packaged.
   3. The chemical formulation of the epoxy grout shall be that recommended by the manufacturer for the particular application.
   4. The mixed epoxy grout system shall have a minimum working life of 45 minutes at 75 degrees F.
   5. The epoxy grout shall develop a compressive strength of 5000 psi in 24 hours and 10,000 psi in 7 Days when tested in accordance with ASTM C579, Method B. There shall be no shrinkage (0.0 percent) and a maximum 4.0 percent expansion when tested in accordance with ASTM C827.
   6. The epoxy grout shall exhibit a minimum effective bearing area of 95 percent. This shall be determined by a test consisting of filling a 2-inch diameter by 4-inch high metal cylinder mold covered with a glass plate coated with a release agent. A weight shall be placed on the glass plate. At 24 hours after casting, the weight and plate shall be removed and the area, in plan, of all voids shall be measured. The surface of the grout shall be probed with a sharp instrument to locate all voids.
      a. The peak exotherm of a 2-inch diameter by 4-inch high cylinder shall not exceed 95 degrees F when tested with 75 degree F material at laboratory temperature. The epoxy grout shall exhibit a maximum thermal coefficient of 30×10^{-6} inches/inch/degree F when tested according to ASTM C531 or ASTM D696.

2.6 BATCHING AND MIXING

A. Concrete shall be "Ready-Mixed" and comply with ACI 318 and ASTM C94, except as specified. Batch mixing at the Site is not permitted. Maximum delivery temperature of concrete is 100 degrees. Minimum delivery temperature as follows:

Atmospheric Temperature	Minimum Concrete Temperature
30 degrees to 40 degrees F	60 degrees F
0 degrees to 30 degrees F	70 degrees F

2.7 ADHESIVE ANCHORS

A. Adhesive anchors shall be cartridge-type, NSF/ANSI 61 approved, suitable for underwater applications, and ICBO approved for seismic requirements. Anchors, which use a pour-in or capsule system for the resin placement, may be considered for use by the Owner, provided that they comply with these Specifications, are appropriate for the intended use, and that test data are submitted substantiating the equivalence of tensile and shear capacities to the anchors specified herein. Minimum depth of embedment shall be 8 times the diameter of the bolt. Adhesive anchors shall be manufactured by:
   1. Hilti Inc., HIT HY-150
   2. ITW Ramset/Redhead, Epcon Ceramic 6 (C6)
   3. Or Approved Equal

B. Stainless steel for underwater or buried applications.

2.8 CONCRETE DESIGN REQUIREMENTS

A. General: Concrete shall be composed of cement, admixtures, aggregates and water. These materials shall be of the qualities specified. The exact proportions in which these materials are to be used for different parts of the work will be determined during the trial batch. In general, the mix shall be designed to produce a concrete capable of being deposited so as to obtain maximum density and minimum shrinkage and, where deposited in forms, to have good consolidation properties and maximum smoothness of surface. In mix designs, the percentage of sand of the total weight of fine and coarse aggregate shall not exceed 41 for hydraulic structures or 50 for all other structures, unless noted otherwise. The aggregate gradations shall be formulated to provide fresh concrete that will not promote rock pockets around reinforcing steel or embedded items. The proportions shall be changed whenever necessary or desirable to meet the required results at no additional cost to the OWNER.

B. Water-Cement Ratio and Compressive Strength: The minimum compressive strength and cement content of concrete shall be not less than that specified in the following tabulation.

Type of Work	Min 28-Day Compr. Strength (psi)	Max Size Aggregate (in)	Minimum Cement per cu yd (lbs)	Max W/C Ratio (by weight)
Structural Concrete/ Footings and grade beams	4,000	1	564	0.45
Concrete toppings	4,000	3/8	564	0.45
Pea Gravel Mix	4,000	3/8	752	0.4

Note: The CONTRACTOR is cautioned that the limiting parameters specified above are not a mix design. Additional cement or water reducing agent may be required to achieve workability demanded by the CONTRACTOR'S construction methods and aggregates. The CONTRACTOR is responsible for any costs associated with furnishing concrete with the required workability.

C. Adjustments to Mix Design: The mixes used shall be changed whenever such change is necessary or desirable to secure the required strength, density, workability, and surface finish and the CONTRACTOR shall be entitled to no additional compensation because of such changes.

D. CONSISTENCY: The quantity of water entering into a batch of concrete shall be just sufficient, with a normal mixing period, to produce a concrete which can be worked properly into place without segregation, and which can be compacted by the vibratory methods herein specified to give the desired density, impermeability and smoothness of surface. The quantity of water shall be changed as necessary, with variations in the nature or moisture content of the aggregates, to maintain uniform production of a desired consistency. The consistency of the concrete in successive batches shall be determined by slump tests in accordance with ASTM C 143. The slumps shall be as follows:

Part of Work	Slump (in)
All concrete, unless noted otherwise	3 inches ± 1 inch
With high range water reducer added	7 inches ± 2 inches
Pea gravel mix	7 inches ± 2 inches

E. Air-entraining agent meeting the requirements of ASTM C 260 shall be used. Sufficient air-entraining agent shall be used to provide a total air content of 3 to 5 percent. The OWNER reserves the right, at any time, to sample and test the air-entraining agent received on the job by the CONTRACTOR. The air-entraining agent shall be added to the batch in a portion of the mixing water. The solution shall be batched by means of a mechanical batcher capable of accurate measurement. Air content shall be tested at the point of placement.

PART 3 EXECUTION

3.1 FORMS

A. Construct in accordance with ACI 347R.
B. Forms:
   1. Treating and Wetting: Coat forms with non-staining form sealer. In hot weather, cool forms by wetting with cool water just before concrete is placed.
   2. Use plywood forms to obtain a smooth finish for concrete surfaces. Tightly butt edges to prevent leakage. Back up all vertical joints solidly and nail edges.

3.2 REINFORCING STEEL

A. General: Details of concrete reinforcement in accordance with ACI 318 and ACI 315, unless otherwise indicated.
B. Installation: Place reinforcement conforming to Greenbook 303-1.7 unless otherwise indicated.
   1. Place reinforcing bars accurately and tie securely at intersections and splices with 16 gauge black annealed wire. Secure reinforcing bars against displacement during the placing of concrete by spacers, chairs, or other similar supports. Portions of supports, spacers, and chairs in contact with formwork shall be made of plastic in areas that will be exposed when building is occupied. Type, number, and spacing of supports conform to ACI 315. Where concrete slabs are placed on ground, use concrete blocks or other non-corrodible material of proper height, for support of reinforcement. Use of brick or stone supports shall not be permitted.
C. Spacing: Minimum clear distances between parallel bars, except in columns and multiple layers of bars in beams shall be equal to nominal diameter of bars. Minimum clear spacing is 1 inch or 1-1/3 times maximum size of coarse aggregate whichever is greater.
D. Bending: Bend bars cold, unless otherwise approved. Do not field bend bars partially embedded in concrete, except when approved by Owner.
E. Cleaning: Metal reinforcement, at time concrete is placed, shall be free from loose flaky rust, mud, oil, or similar coatings that will reduce or destroy bond.
F. Future Bonding: Protect exposed reinforcement bars intended for bonding with future work by wrapping with felt and coating felt with a bituminous compound unless otherwise indicated.

3.3 PLACING CONCRETE

A. Preparation:
   1. Remove hardened concrete, wood chips, shavings, and other debris from forms.
   2. Remove hardened concrete and foreign materials from interior surfaces of mixing and conveying equipment.
   3. Have reinforcement inspected and approved by Owner before depositing concrete.
   4. Place sleeves for penetrations.
   5. Place anchor bolts and other embedments as indicated.

B. Bonding: Before depositing new concrete on or against concrete that has been set, thoroughly roughen and clean existing surfaces of laitance, foreign matter, and loose particles.
   1. Preparing surface:
      a. Remove laitance, mortar, oil, grease, paint, or other foreign material by sand blasting. Clean with vacuum type equipment to remove sand and other loose material.
      b. Broom clean and keep existing slab wet for at least four hours before new concrete is applied.
      c. Use a thin coat of one part portland cement, 1.5 parts fine sand, bonding admixture, and water at a 50:50 ratio; and mix to achieve the consistency of thick paint. Apply to the damp existing concrete by scrubbing with a stiff fiber brush. New concrete shall be placed while the bonding grout is still tacky.

C. Conveying Concrete: Convey concrete from mixer to final place of deposit by a method that will prevent segregation. Method of conveying concrete is subject to approval of Owner.

D. Placing:
   1. Do not place concrete when weather conditions prevent proper placement and consolidation, or when concrete has attained its initial set, or has contained its water or cement content more than 1 1/2 hours.
   2. Deposit concrete as near as practicable in its final position. Prevent splashing of forms or reinforcement with concrete in advance of placing concrete.
   3. Do not drop concrete freely more than 5 feet. Where greater drops are required, use a tremie or flexible spout (canvas elephant trunk), attached to a suitable hopper.
   4. Discharge contents of tremies or flexible spouts in horizontal layers not exceeding 20 inches in thickness, and space tremies such as to provide a minimum of lateral movement of concrete.
   5. Continuously place concrete until an entire unit between construction joints is placed. Rate and method of placing concrete shall be such that no concrete between construction joints will be deposited upon or against partly set concrete, after its initial set has taken place, or after 45 minutes of elapsed time during concrete placement.
   6. Continuously place all concrete with no more than 10 minutes elapsed time between pours. Sequence concrete pours such that each pour is placed on or adjacent to concrete that has been in place no more than 10 minutes.

E. Consolidation: Conform to ACI 309. Immediately after depositing, spade concrete next to forms, work around reinforcement and into angles of forms, tamp lightly by hand, and compact with mechanical vibrator. Vibrate concrete to produce thorough compaction, complete embedment of reinforcement and concrete of uniform and maximum density without segregation of mix. Do not transport concrete in forms by vibration.
   1. Use of form vibration shall be approved only when concrete sections are too thin or too inaccessible for use of internal vibration.

2. Carry on vibration continuously with placing of concrete. Do not insert vibrator into concrete that has begun to set.

3.4 HOT OR COLD WEATHER

A. Follow the recommendations of ACI 305R and ACI 306R for hot and cold weather conditions.

3.5 PROTECTION AND CURING

A. In conformance with Greenbook 303-1.10 and ACI 308, except as otherwise specified herein.
B. Initial curing shall immediately follow the finishing operation. Protect exposed surfaces of concrete from premature drying, wash by rain and running water, wind, mechanical injury, and excessively hot or cold temperatures. Keep concrete not covered with membrane or other curing material continuously wet for at least 7 Days after placing, except wet curing period for high-early-strength concrete shall be not less than 3 Days. Keep wood forms continuously wet to prevent moisture loss until forms are removed. Cure exposed concrete surfaces as described below. Other curing methods may be used if approved by Owner.
   1. Liquid curing and sealing compounds: Apply by power-driven spray or roller in accordance with the manufacturer's instructions. Apply immediately after finishing. Maximum coverage 400 square feet per gallon on steel troweled surfaces and 300 square feet per gallon on floated or broomed surfaces for the curing/sealing compound.
   2. Plastic sheets: Apply as soon as concrete has hardened sufficiently to prevent surface damage. Utilize widest practical width sheet and overlap adjacent sheets 2 inches. Tightly seal joints with tape.
   3. Paper: Utilize widest practical width paper and overlap adjacent sheets 2 inches. Tightly seal joints with sand, wood planks, pressure-sensitive tape, mastic, or glue.

3.6 CONCRETE FINISHES

A. Broom finishes on exposed surfaces.

3.7 GROUTS

A. Use Class A non-shrink grout for the repair of all holes and defects in concrete members which are water bearing, and at all other locations where grout is indicated; except, for those applications where cement grout, Class B non-shrink grout, or epoxy grout are indicated. Class A non-shrink grout may be used in place of Class B non-shrink grout for all applications. Do not use Class A non-shrink grout to grout joints on concrete cylinder pipe.
B. Use Class B non-shrink grout, where indicated, for the repair of holes and defects in concrete members which are not water-bearing and not in contact with soil or other fill material, grouting under all base plates for structural steel members, and grouting railing posts in place.

3.8 EMBEDMENTS AND ANCHORS

A. Unless otherwise indicated or approved by Owner, use adhesive anchors for all embedments of anchor bolts and reinforcing steel in cured concrete. Anchors that are submerged or which are subject to vibration from equipment such as pumps and generators shall be adhesive anchors.
B. Use epoxy grout to embed anchor bolts and reinforcing steel in cured concrete.

END OF SECTION

SECTION 03405

PRECAST CONCRETE UTILITY STRUCTURES

PART 1 GENERAL

A. Summary

1. Section includes:

a) Flow Meter Vault

b) Motor Operated Valve Vault

c) Valve Box

d) Pump Out Vault

e) Electrical Pullboxes (power and control)

2. Related Sections:

a) Section 02320 Trenching, Backfilling, and Compacting for Utilities

b) Section 03300 Cast-in-Place Concrete

c) Section 05500 Miscellaneous Metalwork

B. References

ASTM A36	Structural Steel
ASTM A82	Steel Wire, Plain, for Concrete Reinforcement
ASTM A123	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A185	Steel Welded Wire, Fabric, Plain, for Concrete Reinforcement
ASTM A496	Steel Wire, Deformed, for Concrete Reinforcement
ASTM A497	Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement
ASTM A615	Deformed and Plain Billet-Steel Bars for Concrete
ASTM C478	Precast Reinforced Concrete Manhole Sections
ASTM C150	Portland Cement
ASTM C494	Chemical Admixtures for Concrete

ASTM C890	Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures
ASTM C913	Precast Concrete Water and Wastewater Structures
ASTM C990	Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

C. Submittals

1. Product Data:
   - a) All precast concrete utility structures
   - b) Lid frames
   - c) Lids/hatches
2. Shop Drawings:
   - a) All precast concrete utility structures
   - b) Lid frames
   - c) Lids/hatches
3. Quality Assurance/Control Submittals:
   - a) Design Data:
     - (1) Design calculations for vaults.
   - b) Certificates:
     - (1) Manufacturer(s) certificates stating all precast concrete utility structures conform to specified requirements.

D. Quality Assurance

- a) Manufacturer shall provide certification that all precast concrete structures conform to Contract Document requirements.
- b) Design calculations: Prepared, signed, and stamped by a California registered civil or structural engineer.

PART 2 PRODUCTS

A. General

1. All precast concrete structures and lids shall be designed and fabricated for H-20 traffic loading per ASTM C890, unless otherwise indicated.

B. Manufacturers

1. Vaults:
   - a) Utility Vault Company
   - b) Brooks Products
   - c) Jensen Precast

d) Central Precast

e) Or Approved Equal

2. Boxes:

a) Brooks Products

b) Christy Concrete Products, Inc.

c) Or Approved Equal

3. Access Hatches:

a) U.S.F. Fabrication

b) Bilco

c) Or Approved Equal

4. Ladder Safety Post:

a) U.S.F. Fabrication

b) Bilco

c) Or Approved Equal

5. Pump Out Vaults and CAV Vaults

a) 2 ft by 3 ft square with single spring assisted hatch

b) Jensen K2436-FH33-08PSA or Approved Equal

6. Valve Box

a) Christy G12 Traffic Valve Box or Approved Equal

7. PSV and Flow Meter Vaults

a) 4 ft by 6.5 ft Jensen W-466 or Approved Equal

C. Materials

1. Conforming to ASTM C478 and ASTM C913 as applicable, except as otherwise specified herein.

2. Portland Cement: ASTM C150, Type II.

3. Reinforcing:

a) Steel Wire: ASTM A82, galvanized, or ASTM A496

b) Welded Wire Fabric: ASTM A185, galvanized, or ASTM A497

c) Bars: ASTM A615, deformed. Grade 60.

4. Chemical Admixtures: ASTM C494, type as recommended by manufacturer.

5. Annular Space Sealant Material:

a) Drainage and electrical structures: Class A non-shrink grout.

b) Above-ground structure penetrations: Class A non-shrink grout.

c) All other structures/applications: Watertight Elastomeric Non-Hardening Sealant Material, unless otherwise approved by Owner.

6. Preformed Flexible Joint Sealant: In accordance with ASTM C990

7. Frames and Grates: ASTM A36 Steel; ASTM A123 Galvanized; H-20 Traffic Rated and "Bicycle Safe," except that the grate for the sump inside the motor-operated valve vault may be standard duty, rated for pedestrian traffic.

8. Lids and Frames:

a) Valve and Traffic Boxes: Cast Iron

b) Meter Boxes and Pullboxes: Steel; Diamond Plate Surface; ASTM A123 galvanized; H-20 traffic loading; bolt-down; watertight.

9. Access Hatch (Vaults): Steel or aluminum; Diamond Plate Surface: ASTM A123 Galvanized; H-20 traffic loading; spring-assisted double door with open and close safety assemblies to lock hatch in open position; bolt-down doors; size and number as indicated.

10. Ladder: Galvanized steel

D. Fabrication

1. Dimensions as indicated.

2. Provide extensions as required.

3. Manufacture: Reinforced concrete, composed of regular weight aggregate, portland cement and water, resulting in a unit having a minimum compressive strength of 4000 psi for vaults and 3500 psi for pullboxes, valve boxes, and drain inlets.

4. Allowable Tolerances:

a) Thickness and depth 1/8-inch.

b) Length and width 1/4-inch.

c) Camber or Sweep:

(1) Plus or minus 1/4-inch.

(2) Variation in camber between adjacent and abutting members, 1/8-inch.

d) Inserts, bolts and lid frames: Deviation from location indicated shall be not more than 3/8-inch.

5. Exposed concrete surfaces: Natural cement color, free of honeycomb, pit holes, or other defects.

6. Fabricate wall sections with no vertical joints. Only joints in the horizontal plane are permitted.

7. Fabricate top slabs and bottom slabs as single pieces; no joints.
8. Provide openings for pipes and conduits, as indicated, and as otherwise required to accommodate all equipment located inside the structure.
9. Warped, cracked or broken units are not acceptable.
10. Lid Frames:
    a) Cast into concrete as integral part of box/vault.
    b) Weld steel edge at corners.
11. Lids:
    a) Meter Boxes and Electrical Pullboxes:
        (1) Bolted to frame.
        (2) Electrical System: Labeled "ELECTRICAL"
    b) Valve Boxes:
        (1) Water Valves and Flow Meter: Labeled "S.C.W.A."
    c) Traffic Boxes:
        (1) Corrosion Protection Test Stations: Labeled "C.P. TEST"
12. Ladder:
    a) Accommodate safe ingress and egress.

PART 3 EXECUTION

A. Installation

1. Install where indicated and in accordance with Section 02320 (Trenching, Backfilling, and Compacting for Utilities) for structure bedding and backfill.
2. Bottom slabs shall have even, solid, and complete bearing on base material.
3. Install to provide a level deck surface.
4. Seal pipe/conduit openings after pipe installation with annular space sealant material.
5. Seal horizontal joints with preformed flexible joint sealant (for vaults only).
6. Attach ladder to vault with embedded or adhesive anchor bolts, unless otherwise approved by Owner.

B. Replacement and Repair

1. Replace broken, cracked, and damaged structures.
2. Replace structures exceeding allowable tolerances.

3. Structures having defects, not affecting serviceability of deck, may be repaired with epoxy grout, if approved by Owner. See Section 03300 (Cast-In-Place Concrete).

END OF SECTION

DIVISION 5

METALS

SECTION 05500

MISCELLANEOUS METALWORK

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03405 – Precast Concrete Utility Structures

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Except as otherwise indicated, the current editions of the following standards apply to the Work of this section:

B. Federal Specifications

1.	MIL-G-18015 A (3)	(Ships) Aluminum Planks (6063-T6)
2.	MIL-A-907E	Antiseize Thread Compound, High Temperature

C. Government Standards

1. Cal OSHA Occupational Safety and Health Administration

D. Trade Standards

1. Aluminum Association (AA) publications, as referenced herein.

E. Commercial Standards

1.	AA-M32C22A41	Aluminum Association
2.	AISC	Specifications and Commentary
3.	AISI	Design of Light Gauge, Cold-Formed Steel Structural Members
4.	ASTM A 36	Specification for Structural Steel
5.	ASTM A 48	Specification for Gray Iron Castings
6.	ASTM A 53	Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
7.	ASTM A 123	Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
8.	ASTM A 307	Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile
9.	ASTM A 500	Specification for Cold-Formed Welded and Seamless Carbon Steel Tubing in Rounds and Shapes
10.	ANSI/AWS D1.1	Structural Welding Code – Steel
11.	ANSI/AWS D1.2	Structural Welding Code – Aluminum

12. ANSI/AWS QC1 — Specification for Qualification and Certification of Welding Inspectors

13. NFPA 101 — Life Safety Code

F. I.C.B.O. Evaluation Reports

1. ER-5279 — Simpson SET Adhesive Anchor Systems

1.03 SUBMITTALS

A. Shop Drawings: Shop drawings of all miscellaneous metalwork.

B. Calculations: Engineering calculations shall be stamped by a California Structural or Civil Engineer. Engineering calculations shall include (but not be limited to) brackets, support flanges, and fasteners or anchors.

C. Weld procedures and welder qualifications for any onsite welding.

1.04 QUALITY ASSURANCE

A. All welding shall be inspected by a Contractor-provided inspector qualified in accordance with AWS requirements and approved by the Owner.

PART 2 MATERIALS

2.01 GENERAL REQUIREMENTS

A. Steel

1. Shapes, Plates, Bars — ASTM A 36

2. Pipe, Pipe Columns, Bollards — ASTM A 53, Type E or S, Grade B Standard weight unless noted otherwise

3. Tubes — ASTM A 500 Grade B

B. Corrosion Protection: Unless otherwise indicated, miscellaneous metalwork of fabricated steel, which will be used in a corrosive environment and/or will be submerged in water shall be coated in accordance with Section 09900 and shall not be galvanized prior to coating. All other miscellaneous steel metalwork shall be hot-dip galvanized after fabrication as specified herein.

C. Stainless Steel: Unless otherwise indicated, stainless steel metalwork and bolts shall be of Type 316 stainless steel and shall not be galvanized. Where anaerobic conditions are noted, Type 304 stainless steel shall be used.

D. Cast Iron: Unless otherwise indicated, iron castings shall conform to the requirements of ASTM A 48, Class 50B or better.

2.02 ACCESS HATCHES

A. All hatch hardware shall be Type 316 stainless steel. Hatches shall be gutter-type, or as shown.

B. The design live load shall be 300 psf, unless indicated otherwise with a maximum allowable deflection of 1/150 of the span.

C. Hatch opening sizes, direction of swing of door leaves, and locations, shall be as indicated. Sizes given shall be for the clear opening. All hatches shall have double-leaf doors. Unless indicated otherwise, hinges shall be located on the longer dimension side. Unless indicated otherwise, ladder hatches shall be a minimum of 30 inches wide by 36 inches long, with the ladder centered on the shorter dimension, and the door hinge opposite the ladder.

D. Door leaves shall be a minimum of ¼ inch checkered pattern plate. Hatches shall be provided with an automatic hold-open arm with release handle. Hatches shall be designed for easy opening from both inside and outside. Channel frames shall be a minimum of ¼ inch material with an anchor flange around the perimeter. A continuous EPDM gasket shall be mechanically attached to the frame to create a barrier around the entire perimeter of the cover and significantly reduce the amount of dirt and debris that may enter the channel frame.

E. Hatches shall be designed to be water-tight and shall be equipped with a joint gutter and moat-type edge drain. A 1½ inch diameter (minimum) drain connection shall be provided and located by the manufacturer. The Contractor shall field verify hatch installation conditions and route hatch drain to atmosphere as required for proper drainage.

F. Hatches shall include a recessed hasp for a padlock that is covered by a hinged lid flush with the surface.

G. Hatch cover shall be equipped with an open arm with separate grip handle, which automatically locks the cover in the open position. Hatches without separate grip handles shall not be permitted.

H. Installation shall be in accordance with manufacturer's instructions. Manufacturer shall guarantee against defects in material or workmanship for a period of five years.

I. Manufacturer's or approved equal:

1. Bilco
2. USF Fabrication

2.03 ANTENNA MAST

A. Mast for antenna shall be galvanized steel, telescoping with guy wires, designed to hold the specified antenna.

B. Guy wires shall be 6 strand/18 GA wire.

C. Mast shall be Rohn Products LLC or approved equal.

D. Antenna mast shall be installed according to manufacturer's specifications.

2.04 IRON CASTINGS

A. Iron castings shall be of uniform quality, free from blowholes, porosity, hard spots, shrinkage, distortion, or other defects. They shall be smooth and well cleaned by shotblasting.

B. Covers and grates shall fit together evenly, so that the cover fits flush with the surrounding finishes surface and the cover does not rock or rattle when loading is applied. Round covers and frames shall have machined bearing surfaces.

C. Covers and grates with matching frames shall be designed to support the following loadings:

1. Where located within a structure, the design loading shall match that required for the adjacent floor area, or, if no loading is given, a minimum of 300 pounds per square foot, unless indicated otherwise.

2. Exterior covers and grates shall be designed for AASHTO H20 loading unless indicated otherwise.

2.05 BOLTS AND ANCHORS

A. Standard Service Bolts (Not Buried or Submerged): Except where otherwise indicated, all bolts, anchor bolts, and nuts shall be ASTM A307 Grade B Carbon steel cadmium-plated.

B. Buried or Submerged Bolts: All bolts, anchor bolts, nuts, and washers which are buried, submerged, or below the top of the wall inside any hydraulic structure shall be Type 316 stainless steel conforming to ASTM A 193 for bolts and to ASTM A 194 for nuts. All threads on stainless steel bolts shall be formed by means of rolling, not cutting or grinding. All threads on stainless steel bolts shall be protected with an antiseize lubricant suitable for submerged stainless steel bolts, to meet government specification MIL-A-907E.

1. Antiseize lubricant shall be classified as acceptable for potable water use by the NSF.

C. Bolt Requirements

1. The nuts shall be capable of developing the full strength of the bolts. Threads shall be Coarse Thread Series conforming to the requirements of the American Standard for Screw Threads. All bolts and cap screws shall have hexagon heads and nuts shall be Heavy Hexagon Series.

2. The length of all bolts shall be such that after joints are made up, each bolt shall extend through the entire nut a minimum of 1/2-inch.

D. Expansion Anchors: Material and Installation shall conform to ICBO ER-4627. Expansion anchors shall be Hilti "Kwik-Bolt II" or ICBO approved equal. Lead caulking anchors will not be permitted. Size shall be as indicated. Expansion type anchors shall be 304 stainless steel. Expansion anchors may only be used where specifically detailed. Expansion type anchors shall not be used unless approved by the Owner.

2.06 SURFACE PREPARATION AND SHOP PAINTING

A. Surface preparation and shop painting is required for all ferrous metal, equipment and accessories. Stainless steel shall not be painted.

B. All ferrous metal surfaces shall be cleaned and provided with two coats of priming paint in accordance with the applicable requirements of Section 09800, Painting and Coating. All prime coat materials shall be compatible with the finish coat materials to be furnished under Section 09800. All ferrous metal surfaces may be given two coats of the manufacturer's standard paint system in lieu of the priming paint, provided that the total mil thickness of paint is equal to that specified for the priming paint.

C. Minimum acceptable surface preparation for any equipment furnished with manufacturer's standard paint system shall include cleaning with a Commercial Sandblast (SSOC-SP6).

D. Surface treatment shall be required on all stainless steel. After rolling, only stainless steel tools shall be used. An acid wash shall be applied after rolling.

2.07 DISSIMILAR METALS

A. Where dissimilar metals are in contact, protect surfaces with a coat conforming to

B. MPI 79 to prevent galvanic or corrosive action. Where aluminum is in contact with concrete, plaster, mortar, masonry, wood, or absorptive materials subject to wetting, protect with

C. ASTM D 1187, asphalt-base emulsion.

PART 3 EXECUTION

3.01 WELDING

A. Method: All welding shall be by the metal-arc method or gas-shielded arc method as described in the American Welding Society's "Welding Handbook" as supplemented by other pertinent standards of the AWS. Qualification of welders shall be in accordance with the AWS Standards governing same.

B. Quality: In assembly and during welding, the component parts shall be adequately clamped, supported and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall be as indicated by the AWS Code. Upon completion of welding, all weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance, with uniform weld contours and dimensions. All sharp corners of material to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.

C. Aluminum: All exposed welds shall be ground smooth and flush and shall be polished and anodized. Discoloration of exposed aluminum surfaces, whether or not due to welding, shall constitute a basis for rejection of the entire assembly.

3.02 GALVANIZING

A. All structural steel plates shapes, bars and fabricated assemblies required to be galvanized shall, after the steel has been thoroughly cleaned of rust and scale, be

galvanized in accordance with the requirements of ASTM A 123. Any galvanized part that becomes warped during the galvanizing operation shall be straightened. Field repairs to galvanizing shall be made using "Galvinox," "Galvo-Weld," or equal.

3.03 CRAFTSMANSHIP

A. All work shall be performed by craftsmen experienced in the fabrication of architectural metal work. Exposed surfaces shall be free from defects or other surface blemishes. All dimensions and conditions shall be verified in the field in advance. All joints, junctions, miters, and butting sections shall be precision-fitted, with no gaps occurring between sections, and all surfaces shall be flush and aligned.

3.04 DRILLED ANCHORS

A. Drilled anchors and reinforcing bars shall be installed in strict accordance with the applicable I.C.B.O. Evaluation Report and manufacturer's instructions. Holes shall be roughened with a brush on a power drill, cleaned and dry. Drilled anchors shall not be installed until the concrete has reached the specified 28-day compressive strength. Adhesive anchors shall not be loaded until the adhesive has reached its indicated strength in accordance with the manufacturer's instructions.

END OF SECTION

DIVISION 9

FINISHES

SECTION 09900

PAINTING AND COATING

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall provide painting and coatings, complete and in place, in accordance with the Contract Documents.

B. Definitions:

1. The term "paint," "coatings," or "finishes" as used herein, shall include surface treatments, emulsions, enamels, paints, epoxy resins, and all other protective coatings, excepting galvanizing or anodizing, whether used as a pretreatment, primer, intermediate coat, or finish coat.

2. The term "DFT" means minimum dry film thickness.

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Except as otherwise indicated, the current editions of the following apply to the Work of this Section:

1. References herein to "SSPC Specifications" or "SSPC" shall mean the published standards of SSPC, the Society for Protective Coatings.

2. References herein to "NACE" shall mean the published standards of the National Association of Corrosion Engineers.

3. References herein to “ANSI/AWWA” shall mean the published standards of the American Water Works Association including:

a)	ANSI/AWWA C205	Cement-Mortar Protective Lining and Coating for Steel Water Pipe – 4 in. (100mm) and Larger – Shop Applied
b)	ANSI/AWWA C209	Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines
c)	ANSI/AWWA C210	Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
d)	ANSI/AWWA C213	Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines
e)	ANSI/AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines

f) ANSI/AWWA C217 — Cold-Applied Petrolatum Tape and Petroleum Wax Tape Coatings for Exterior of Special Sections, Connections, and Fittings for Buried Steel Water Pipelines

4. Federal Specifications

a) OSHA 1910.144 — Safety Color Code for Marking Physical Hazards

5. ASTM Standards

a) C-309 — Liquid Membrane-Forming Compounds for Curing Concrete

6. Regulatory Agency Requirements: Coatings for surfaces in contact with raw or potable water shall impart no taste or odor to the water nor result in any organic or inorganic content in excess of the maximum contaminant level established by applicable laws or regulations including NSF Standards. All coatings shall be approved by the local Air Pollution Control District. The Contractor shall revise painting systems specified herein to provide manufacturer's regulatory agency approved coating system where required. All painting systems shall be VOC compliant. Equivalent systems are to be submitted at no additional costs to meet any new regulations.

B. The Work of this Section shall comply with the current edition of the Uniform Building Code

C. Inspection records of shop or field-applied coatings and linings for buried or submerged items shall be submitted within 15 days after the work has been accepted.

1.03 SUBMITTALS

A. The following shop drawings shall be submitted in compliance with City Utility Standards, Section 0700, Paragraph 1.20.

1. Submit coating manufacturer's technical and material safety data sheets for the products to be applied. Data sheets shall show the following information at a minimum, but shall show all data necessary to indicate conformance to specifications:

a) Percent solids by volume.

b) Minimum and maximum recommended dry-film thickness per coat for prime, intermediate, and finish coats.

c) Recommended surface preparation.

d) Recommended thinners.

e) Statement verifying that the specified prime coat is recommended by the manufacturer for use with the specified intermediate and finish coats.

f) Application instructions including recommended equipment and temperature limitations.

g) Curing requirements and instructions.

h) Colors (where applicable).

i) Submit the name of the company and abrasive to be used, the generic type of abrasive, the CARB certification, and product data sheets.

1.04 QUALITY ASSURANCE

A. All materials of a specified painting system, including primer, intermediate, and finish coats, shall be produced by the same manufacturer. Thinners, cleaners, driers, and other additives shall be as recommended by the paint manufacturer for the particular coating system.

1. Deliver paints to the jobsite in the original, unopened containers.

1.05 SPECIAL CORRECTION OF DEFECTS REQUIREMENTS

A. Warranty Inspection: A warranty inspection may be conducted during the eleventh month following completion of all coating and painting work. The Contractor and a representative of the coating material manufacturer shall attend this inspection. All defective work shall be repaired in accordance with these Specifications and to the satisfaction of the City. The City may, by written notice to the Contractor, reschedule the warranty inspection to another date within the 2-year correction period, or may cancel the warranty inspection altogether. If a warranty inspection is not held, the Contractor is not relieved of its responsibilities under the Contract Documents.

1.06 SAFETY AND HEALTH REGULATIONS

A. General: In accordance with the requirements of OSHA Safety and Health Standards for Construction (29CFR1926) and the applicable requirements of regulatory agencies having jurisdiction, as well as manufacturer's printed instructions and appropriate technical bulletins and manuals, the Contractor shall provide and require use of personnel protective lifesaving equipment for persons working in or about the project site.

B. Head and Face Protection and Respiratory Devices: Equipment shall include protective helmets which shall be worn by all persons while in the vicinity of the Work. In addition, workers engaged in or near the work during sandblasting shall wear OSHA approved eye and face protection devices and air purifying, halfmask or mouthpiece respirators. Barrier creams shall be used on any exposed areas of skin.

C. Ventilation: Where ventilation is used to control hazardous exposure, all equipment shall be explosion-proof. Forced air ventilation shall be provided to

reduce the concentration of air contaminant to a safe limit. Air circulation and exhausting of solvent vapors shall be continued until coatings have fully cured.

D. Sound Levels: Whenever the occupational noise exposure exceeds maximum allowable sound levels, the Contractor shall implement furnish and require the use of approved ear protective devices.

E. Illumination: Adequate illumination shall be provided while Work is in progress, which may include explosion-proof lights, scaffolding and electrical equipment. Whenever required by the Engineer, the Contractor shall provide additional illumination to cover all areas to be inspected. The level of illumination for inspection purposes shall be determined by the Engineer.

F. Temporary Ladders and Scaffolding: All temporary ladders and scaffolding shall conform to applicable safety requirements. They shall be erected where requested by the Engineer to facilitate inspection and shall be moved by the Contractor to locations as requested by the Engineer.

1.07 PAINT COLORS

A. All colors and shades of colors of all coats of paints and protective coating materials shall be as selected by the City. Each coat shall be of slightly different shade, as directed by the City, to facilitate inspection of surface coverage of each coat.

PART 2 MATERIALS

2.01 GENERAL

A. The following index lists the various painting and coating systems by service and generic type.

PAINT COATINGS SYSTEM INDEX

No.	Title	Generic Coating
Submerged Metal Coating System		
5	Submerged or Intermittently Submerged Metal, Potable and Raw Water	Epoxy
Exposed Metal Coating Systems		
10	Exposed Metal, Corrosive Environment	Zinc / Epoxy (3 Coat System)
15	Exposed Metal, Atmospheric Weathering Environment	Polyurethane
20	Exposed Metal, Exterior	Polyurethane Waterborne
PVC, CPVC and FRP Coating System		
41	PVC, CPVC and FRP, Ultraviolet Exposure	Polyurethane
Metal in Contact with Concrete, Coating System		
51	Aluminum and Concrete	Bituminous

PAINT COATINGS SYSTEM INDEX

No.	Title	Generic Coating
	Plaster, Wood, Masonry and Drywall Coating System	
60	Plaster, Wood, Masonry and Drywall	Acrylic Latex

B. These systems are specified in detail in the following paragraphs. For each coating, the required surface preparation, prime coat, intermediate coat (if required), topcoat, and coating thicknesses are described. Mil thicknesses shown are minimum dry-film thicknesses. At least two manufacturer's products are listed for each system.

2.02 SUBMERGED METAL COATING SYSTEM

A. System No. 5 - Submerged Metal, Potable and Raw Water:

1. Type: Two component, three-coat epoxy system. For potable water applications, coating shall be certified by NSF in accordance with ANSI/NSF Std. 61.

2. Service Conditions: For use with steel structures, piping, valves, or equipment in potable water service.

3. Surface Preparation: SSPC-SP 10.

4. Coating System: Apply three coats of Tnemec Series V140 or V140F Pota-Pox Plus, or ICI/Devoe BarRust 233H, or CITY approved equal. Apply to a minimum dry film thickness of 16 mils total.

2.03 EXPOSED METAL COATING SYSTEMS

A. System No. 10 - Exposed Metal, Corrosive Environment:

1. Type: High build epoxy finish coat having a minimum volume solids of 60%, with a zinc rich prime coat.

2. Service Conditions: For use with metal structures, pipes, or valves subjected to water condensation; inside vaults or buildings; subject to chemical fumes; and chemical contact.

3. Surface Preparation: SSPC-SP 10.

4. Prime Coat: two component, zinc rich primer recommended by the manufacturer for overcoating with a high build epoxy finish coat. Minimum zinc content shall be 12 pounds per gallon. Provide Tnemec 90-97 Tneme-Zinc, or ICI/Devoe Catha-Coat 304V, or City approved equal. Apply to a thickness of 3 mils.

5. Finish Coats: Provide Tnemec Series V69 Epoxoline II, or ICI/Devoe Devran 224HS, or City approved equal. Apply to a minimum dry film thickness of 6 mils per coat for a total of 12 mils.

B. System No. 15 - Exposed Metal, Atmospheric Weathering Environment:

1. Type: Polyurethane enamel having a minimum volume solids content of 46% with an epoxy primer.
2. Service Conditions: For use on exterior metal and piping subject to sunlight and weathering.
3. Surface Preparation: SSPC-SP 6.
4. Prime Coat: Provide Tnemec Series V69 Epoxoline II, or ICI/Devoe Devran 224HS, or CITY approved equal. Apply to a minimum dry film thickness of 3 mils DFT.
5. Finish Coats: Provide one coat Tnemec Series 1075 Endura-Shield II, or ICI/Devoe Devthane 379HS, or CITY approved equal. Apply to a minimum dry film thickness of 3 mils.

C. System No. 20 - Exposed Metal, Exterior:

1. Type: Gloss Polyurethane enamel with OSHA safety color coding.
2. Service Conditions: For use on exterior metal appurtenances, such as valve box lids, hydrant heads, guard posts, air valve enclosures, and water sample point enclosures.
3. Surface Preparation: SSPC-SP 1. Apply one coat of Oakite 747LTS on galvanized steel. Bronze surfaces shall be lightly scarified.
4. Prime Coat: Tnemec Series 135 Chembuild; 2 - 3 mils or CITY approved equal.
5. Finish Coats: Provide two coats JFB Hart HP-105, or Tnemec Series 1080 Endura-Shield WB (OSHA White), No. 02SF (OSHA Yellow), No. 04SF (OSHA Orange), No. 08SF (OSHA Green), or No. 11SF (OSHA Blue), 2 mils each coat; or City approved equal.

2.04 PVC, CPVC AND FRP COATING SYSTEM

A. System No. 41 - PVC, CPVC and FRP, Ultraviolet Exposure:

1. Type: Polyurethane enamel having a minimum volume solids of 52%.
2. Service Conditions: PVC or CPVC piping and FRP exposed to sunlight.
3. Surface Preparation: SSPC-SP 1. Then lightly abrade the surface with medium-grain garnet paper.
4. Prime Coat: Provide one coat @ 3 mils DFT of Tnemec V69 Epoxoline II, or ICI/Devoe Devran 203, or City approved equal.
5. Finish Coat: Provide one coat @ 2 mils DFT of Tnemec Series 1080 Endura-Shield WB, or JFB Hart HP-105, or City approved equal.

2.05 METAL IN CONTACT WITH CONCRETE, COATING SYSTEM

A. System No. 51 - Aluminum and Concrete:

1. Type: Bituminous coating having a minimum volume solids of 70% coal-tar epoxy.
2. Service Conditions: Coat areas of aluminum grating, stairs, framing, or structural members in contact with concrete with this system.
3. Surface Preparation: SSPC-SP 1. Then prepare per SSPC-SP2 or SP3.
4. Prime Coat: Apply 3 mils epoxy primer to surface before finish coats. Provide Tnemec 139 Chembuild or City approved equal.
5. Finish Coat(s): Provide one or two coats Devtar 5AHS, Tnemec 46H-413 Tneme-Tar @ 20 mils total DFT; or City approved equal.

2.06 PLASTER, WOOD, MASONRY AND DRYWALL COATING SYSTEM

A. System No. 60 - Plaster, Wood, Masonry and Drywall, Normal Exposure:

1. Type: Acrylic latex coating having a minimum volume solids of 40%.
2. Service Conditions: For use in coating weather-exposed or enclosed concrete masonry, drywall, wood, and plaster.
3. Surface Preparation: Surfaces shall be dry, clean, and free of contaminants.
4. Prime Coat: Self-priming.
5. Finish Coats: Provide two coats Tnemec Series 6, Tneme-cryl, 2 mils each; two coats Kop-Coat 600, 2 mils each; or City approved equal.

2.07 ABRASIVES FOR SURFACE PREPARATION

A. Abrasives used for dry unconfined blast cleaning shall conform to the requirements of the State of California Air Resources Board (CARB) Executive Order G-425. Use abrasives that are currently certified by CARB and appear on the Approved Abrasives List.

B. Abrasives used for preparation of iron and steel surfaces shall be one of the following:

1. 16 to 30 or 16 to 40 mesh silica sand or mineral grit
2. 20 to 40 mesh garnet
3. Crushed iron slag, 100% retained on No. 80 mesh
4. SAE Grade G-40 or G-50 iron grit

C. Abrasives used for preparation of copper and aluminum surfaces shall be one of the following:

1. Crushed slag, 80 to 100 mesh
2. Very fine silica sand, 80 to 100 mesh

D. In the above gradations, 100% of the material shall pass through the first stated sieve size and 100% shall be retained on the second stated sieve size.

PART 3 EXECUTION

3.01 WEATHER CONDITIONS

A. Do not paint in the rain, wind, snow, mist, and fog or when steel or metal surface temperatures are less than 5 degrees F above the dew point.

B. Do not apply paint when the relative humidity is above 85% or the temperature is above 90 degrees F.

C. Do not paint when temperature of metal to be painted is above 120 degrees F.

D. Do not apply paints if air or surface temperature is below 40 degrees F or expected to be below 40 degrees F within 24 hours.

E. Do not apply epoxy, acrylic latex, and polyurethane paints on an exterior or interior surface if air or surface temperature is below 60 degrees F or expected to drop below 60 degrees F in 24 hours.

3.02 SURFACE PREPARATION

A. Do not sandblast or prepare more surface area than can be coated in one day. Remove all sharp edges, burrs, and weld spatter. Do not sandblast PVC, CPVC, or FRP piping or equipment. Do not sandblast epoxy, enamel coated, or fusion-bonded epoxy pipe that has already been factory coated, except to repair scratched or damaged coatings.

B. Surface preparation shall conform to the SSPC specifications as follows:

Solvent Cleaning	SP 1
Hand Tool Cleaning	SP 2
Power Tool Cleaning	SP 3
White Metal Blast Cleaning	SP 5
Commercial Blast Cleaning	SP 6
Brush-Off-Blast Cleaning	SP 7
Pickling	SP 8
Near-White Blast Cleaning	SP 10

C. Wherever the words "solvent cleaning," "hand tool cleaning," "wire brushing," or "blast cleaning" or similar words are used in these specifications or in paint manufacturer's specifications, they shall be understood to refer to the applicable SSPC (Steel Structure Painting Council, Surface Preparation Specifications, ANSI A159.1) specifications listed above.

D. Dust blasting is defined as cleaning the surface through the use of very fine abrasives, such as siliceous or mineral abrasives, 80 to 100 mesh. Apply a fine etch to the metal surface to clean the surface of any contamination or oxide.

E. Remove oil, grease, dust, dirt, rust, moisture, mill scale, and all other foreign or interference substances which would adversely affect the adhesion or durability of the coating system.

F. Remove oil and grease from metal surfaces in accordance with SSPC-SP 1. Use clean cloths and cleaning solvents and wipe dry with clean cloths. Do not leave a film or greasy residue on the cleaned surfaces before sandblasting.

G. Remove weld spatter and weld slag from metal surfaces and grind smoothly rough welds, beads, peaked corners, and sharp edges in accordance with SSPC-SP 2 and SSPC-SP 3.

H. Neutralize welds with a chemical solvent that is compatible with the specified coating materials. Use clean cloths and chemical solvent. Wipe dry with clean cloths. Do not leave a residue on the cleaned surfaces.

3.03 LIMITATIONS ON ABRASIVE BLAST CLEANING

A. The specified limitations on the application of coatings also apply to blast cleaning. Do not blast clean when conditions would not permit the subsequent application of coating. Blast clean only the area that can be coated with primer during the same day. In the event that a cleaned surface colors, oxidizes, or becomes moist, blast clean it again before applying the coating.

3.04 ABRASIVE BLAST CLEANING

A. Use dry abrasive blast cleaning for metal surfaces. Do not use abrasives in automatic equipment that have become contaminated. When shop or field blast cleaning with handheld nozzles, do not recycle or reuse blast particles.

B. After blast cleaning and prior to application of coating, dry clean surfaces to be coated by dusting, sweeping, and vacuuming to remove residue from blasting. Apply the specified primer or touch-up coating within the period of an eight-hour working day. Do not apply coating over damp or moist surfaces. Reclean prior to application of primer or touch-up coating any blast cleaned surface not coated within said eight-hour period.

C. Keep the area of the work in a clean condition and do not permit blasting particles to accumulate and constitute a nuisance or hazard.

D. During blast cleaning, prevent damage to adjacent coatings. Schedule blast cleaning and coating such that dust, dirt, blast particles, old coatings, rust, mill scale, etc., will not damage or fall upon wet or newly coated surfaces.

E. Abrasives and other debris resulting from the surface preparation and coating work shall be removed and disposed of by the Contractor.

3.05 PROCEDURES FOR ITEMS HAVING SHOP-APPLIED PRIME COATS

A. Handle shop-primed items with care during unloading, installation, and erection operations to minimize damage. Do not place or store shop-primed items on the ground or on top of other work unless ground or work is covered with a protective covering or tarpaulin. Place shop-primed items above the ground upon platforms, skids, or other supports.

3.06 FIELD TOUCH-UP OF SHOP-APPLIED PRIME COATS

A. Remove oil and grease surface contaminants on metal surfaces in accordance with SSPC-SP 1. Use clean rags wetted with a degreasing solution, rinse with clean water, and wipe dry.

B. Remove dust, dirt, salts, moisture, chalking primers, or other surface contaminants that will affect the adhesion or durability of the coating system. Use a high-pressure water blaster or scrub surfaces with a broom or brush wetted with a solution of trisolium phosphate, detergent, and water. Before applying intermediate or finish coats to inorganic zinc primers, remove any soluble zinc salts that have formed by means of scrubbing with a stiff bristle brush. Rinse scrubbed surfaces with clean water.

C. Remove loose or peeling primer and other surface contaminants not easily removed by the previous cleaning methods in accordance with SSPC-SP 7. Take care that remaining primers are not damaged by the blast cleaning operation. Remaining primers shall be firmly bonded to the steel surfaces with blast cleaned edges feathered.

D. Remove rust, scaling, or primer damaged by welding or during shipment, storage, and erection in accordance with SSPC-SP 10. Take care that remaining primers are not damaged by the blast cleaning operation. Remaining primers shall be firmly bonded to the steel surfaces with blast cleaned edges feathered.

E. Use repair procedures on damaged primer which protects adjacent primer. Blast cleaning may require the use of lower air pressure, smaller nozzles, and abrasive particle sizes, short blast nozzle distance from surface, shielding, and/or masking.

F. After abrasive blast cleaning of damaged and deflective areas, remove dust, blast particles, and other debris by dusting, sweeping, and vacuuming; then apply the specified touch-up coating.

G. Surfaces that are shop primed with inorganic zinc primers shall receive a field touch-up of organic zinc primer to cover all scratches or abraded areas.

H. Other surfaces that are shop primed shall receive a field touch-up of the same primer used in the original prime coat.

3.07 PAINT MIXING

A. Prepare multiple-component coatings using all of the contents of the container for each component as packaged by the paint manufacturer. Do not use partial batches. Do not use multiple-component coatings that have been mixed beyond their pot life. Provide small quantity kits for touchup painting and for painting other small areas. Mix only the components specified and furnished by the paint manufacturer. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.

3.08 PROCEDURES FOR THE APPLICATION OF COATINGS

A. Conform to the requirements of SSPC-PA 1. Follow the recommendations of the coating manufacturer including the selection of spray equipment, brushes,

rollers, cleaners, thinners, mixing, drying time, temperature and humidity of application, and safety precautions.

B. Stir, strain, and keep coating materials at a uniform consistency during application. Apply each coating evenly, free of brush marks, sags, runs, holidays, and other evidence of poor workmanship. Use a different shade or tint on succeeding coating applications to indicate coverage where possible. Finished surfaces shall be free from defects or blemishes.

C. Do not use thinners unless recommended by the coating manufacturer. If thinning is allowed, do not exceed the maximum allowable amount of thinner per gallon of coating material. Stir coating materials at all times when adding thinner. Do not flood the coating material surface with thinner prior to mixing. Do not reduce coating materials more than is absolutely necessary to obtain the proper application characteristics and to obtain the specified dry-film thicknesses.

D. Remove dust, blast particles, and other debris from blast cleaned surfaces by dusting, sweeping, and vacuuming. Allow ventilator fans to clean airborne dust to provide good visibility of working area prior to coating applications. Remove dust from coated surfaces by dusting, sweeping, and vacuuming prior to applying succeeding coats.

E. Observe minimum and maximum recoat times between primer and succeeding coating applications to achieve maximum cross-linking of coatings. If the recommended minimum or maximum recoat time is exceeded, prepare the surface as directed by the City's Inspector. Apply a second application of the primer or coating if the maximum recoat time has been exceeded.

F. Apply coating systems to the specified minimum dry-film thicknesses as measured from above the peaks of the surface profile. Measurement will be in accordance with SSPC PA-2 and will be corrected for the magnetic effect of the surface profile.

G. Apply primer immediately after blast cleaning and before any surface rusting occurs, or any dust, dirt, or any foreign matter has accumulated. Reclean surfaces by blast cleaning that have surface colored or become moist prior to coating application.

H. Apply a brush coat of primer on welds, sharp edges, nuts, bolts, and irregular surfaces prior to the application of the primer and finish coat. The brush coat shall be done prior to and in conjunction with the spray coat application. Apply the spray coat over the brush coat.

I. Epoxy coated surfaces or other multi-component materials exposed to excessive sunlight or an excessive time element beyond manufacturer's recommended recoat cycle, shall be scarified by Brush-Off Blast Coating (SSPC SP-7) or methods approved by the City's Inspector, prior to application of additional coating. Scarified coating shall have sufficient depth to assure a mechanical bond of subsequent coat, as recommended by the manufacturer. Special care shall be

made to assure that any underlying scarification does not adversely effect the visual appearance of the finish coat.

3.09 SURFACES NOT TO BE COATED

A. The following surfaces shall not be painted and must be protected during painting of adjacent areas unless otherwise noted on the Drawings or in other Specification sections:

1. Steel to be encased in concrete or masonry
2. Cement mortar coated pipe and fittings
3. Stainless steel
4. Metal plates/nameplates or letters
5. Concrete surfaces
6. Fencing
7. Copper tubing, red brass piping and PVC piping except where such piping occurs in rooms where the walls are painted, or required for color coding
8. Electrical fixtures except for factory coatings
9. Grease fittings
10. Buried pipe unless specifically required in the piping specifications
11. Plastic and fiberglass surfaces
12. Aluminum handrails, stairs and grating, unless in contact with concrete
13. Platform gratings, stair treads, door thresholds, and other walking surfaces
14. Roofing
15. Galvanized steel

3.010 PROTECTION OF SURFACES NOT TO BE PAINTED

A. Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not intended to be painted. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.

B. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process. Mask openings in motors to prevent paint and other materials from entering the motors.

3.011 SURFACES TO BE COATED

A. Coat mechanical equipment as described in the various mechanical equipment specifications. Color shall match the color of the connecting piping.

B. Coat aboveground and exposed piping or piping in vaults and structures as described in the various piping specifications. Color shall be as indicated or as selected by the Construction Manager.

C. Coat valves as described in the various valve specifications. Above ground valves or valves in vaults and structures shall match the color of the connecting piping.

D. Coat aluminum surfaces in contact with concrete per System No. 51.

E. Coat exposed surfaces of enclosures, guard posts, marker posts, fire hydrants, valve boxes, and test boxes as described in the particular specifications for the above items.

3.012 SHOP AND FIELD INSPECTION AND TESTING

A. General: Furnish the City a minimum of 5 working days advance notice of the start of any field surface preparation work or coating application work, and a minimum of 7 days advance notice of the start of any shop surface preparation work.

B. All inspection, testing, and operation of inspection tools for field-applied coatings and linings shall be performed only in the presence of the Construction Manager, unless the City has granted prior approval to perform such Work in its absence.

C. The inspection shall be performed by a third-party inspection agency acceptable to the City and certified in the inspection of coating and lining application procedures.

D. Inspection by the Engineer, or the waiver of inspection of any particular portion of the Work, shall not relieve the Contractor of its responsibility to perform the Work in accordance with these Specifications.

E. For external or internal application of lining or coating materials for buried or submerged piping systems, the Contractor shall supply inspection procedures for use by the City. Procedures shall be supplied in advance of starting work.

F. Inspection Devices: Furnish, until final acceptance of such coatings, inspection devices in good working condition for the detection of holidays and measurement of dry-film thicknesses of protective coatings. Dry-film thickness gauges shall be made available for the Engineer's use at all times while coating is being done, until final acceptance of such coatings. Furnish the services of a trained operator of the holiday detection devices until the final acceptance of such coatings. Holiday detection devices shall be operated only in the presence of the Engineer.

G. Holiday Testing: Holiday test all coated ferrous surfaces, other surfaces which will be submerged in water or other liquids, or surfaces which are enclosed in a vapor space in such structures and surfaces coated with any of the submerged and severe service coating systems. Areas which contain holidays shall be marked and repaired or recoated in accordance with the coating manufacturer's printed instructions and then retested. Electrical inspection for linings and

coatings shall be in accordance with applicable NACE standards RPO 188 and/or RPS 274.

1. Coatings with Thickness Exceeding 20 Mils: For surfaces having a total dry film coating thickness exceeding 20 mils: pulse-type holiday detector such as Tinker & Rasor Model AP-W, D.E. Stearns Co. Model 14/20, or equal shall be used. The unit shall be adjusted to operate at the voltage required to cause a spark jump across an air gap equal to twice the specified coating thickness.

2. Coatings with Thickness of 20 Mils or Less: For surfaces having a total dry film coating thickness of 20 mils or less, Tinker & Rasor Model M1 nondestructive type holiday detector, K-D Bird Dog, or equal shall be used. The unit shall operate at less than 75 V. For thicknesses between 10 and 20 mils, a nonsudsing type wetting agent, such as Kodak Photo-Flo, or equal, shall be added to the water before wetting the detector sponge.

H. Film Thickness Testing: On ferrous metals, the dry film coating thickness shall be measured in accordance with the SSPC "Paint Application Specification No. 2" or other surface preparation standards using a magnetic-type dry film thickness gauge such as Mikrotest model FM, Elcometer model 111/1EZ, or equal. Each coat shall be tested for the correct thickness. No measurements shall be made until at least 8 hours after application of the coating. On nonferrous metals and other substrates, the coating thicknesses shall be measured at the time of application using a wet film gauge.

I. Surface Preparation: Evaluation of blast cleaned surface preparation work will be based upon comparison of the blasted surfaces with the standard samples available from the NACE, using NACE standards TM-01-70 and TM-01-75.

J. Third-Party Inspection: At no additional cost to the City, the inspection of coatings and linings for submerged and buried service conditions shall be performed by a third-party inspection agency acceptable to the Engineer and certified in the inspection of coating and lining application procedures.

END OF SECTION

DIVISION 13

SPECIAL CONSTRUCTION

SECTION 13110 – CATHODIC PROTECTION

PART 1 GENERAL

1.01

A. Summary

1. Section Includes:

a) Insulating flange joints, dielectric shields, bonding cables and wires, including anodes and test stations for cathodic protection

B. References

NACE RP0169	Standard Recommended Practice, Control of External Corrosion on Underground or Submerged Metallic Piping Systems
NACE RP0286	Standard Recommended Practice, The Electrical Isolation of Cathodically Protected Pipelines
NFPA NEC Article 310	Conductors for General Wiring

C. Submittals

1. Product Data:

a) Test stations

b) Mounting posts

c) Prepackaged anodes

d) Permanent reference cells

e) Leads and cables, including color designations, and cable identifiers

f) Dielectric shields

g) Insulating flange kits

h) Underground marking tape

2. Quality Assurance/Control Submittals:

a) System currents and voltages

b) Evidence of experience required under paragraph 1.4B of this Section 13110.

c) Corrosion Survey Test Report:

(1) Contents of report:

(a) anode current for pipeline.

(b) detailed test procedures and results of field testing and inspection.

(c) all field test data obtained during the Work.

(d) analysis of the data.

(e) list of deficiencies and proposed resolutions.

(2) Clearly define all parameters.

(3) Tabulate test station data. Table(s) shall include:

(a) actual station numbers as indicated.

(b) brief description of location.

(c) potential readings.

(d) nearby landmarks.

(e) GPS coordinates with 3 feet accuracy

(4) Place report in a 3-ring binder.

(5) Submit upon approval of cathodic protection system.

3. Installation, Operation, and Maintenance Manual

a) Test stations traffic boxes

b) Prepackaged anodes

c) Permanent reference cells

d) Leads and cables, including color designations, and cable identifiers

e) Insulating flange kits

f) Corrosion survey test report

g) Record drawings including test station locations with site description

D. Quality Assurance

1. All Work under this Section 13110 shall be in accordance with the following:

a) NACE RP0169

b) NACE RP0286

c) NFPA NEC Article 310

2. A registered professional corrosion engineer or NACE-Accredited corrosion specialist shall supervise corrosion work and prepare the Corrosion Survey Report.

E. Locations of Equipment

1. The locations of cathodic protection equipment, devices, and appurtenances, as indicated, are approximate only. Determine exact locations in the field, subject to the approval of Owner.

PART 2 PRODUCTS

2.01

A. Lead and Cables

1. All leads except shielded cable for permanent reference electrode:

a) Visually inspect all leads. If any damage to the wire or insulation is discovered, replace anode assembly.

b) Rated for 600 volts.

c) Conform to NFPA NEC Article 310

d) Stranded single conductor copper.

e) Length as required for construction installation.

f) For all leads terminating at a test station, factory-attach a cable identifier within 4 inches of end of lead at terminal board in test station.

g) Cable identifier shall meet the following requirements:

(1) Print letters and numbers 3/16-inch minimum.

(2) Wrap-around type with a high resistance to oils, solvents, and mild acids.

(3) Fully encircle cable with imprinted alphanumeric characters.

h) Lead colors, minimum sizes, and insulation type unless otherwise indicated:

(1) Test leads:

(a) Size: #10 THHN

(b) Color: White unless otherwise indicated.

(2) Anode leads:

(a) Size: #12 THHN unless otherwise indicated.

(b) Color: Black

(3) Structure leads:

(a) Size: #8 or #10 THHN

(b) Color: Black, white, green

i) Equip test leads with a steel rod for connecting to the pipeline or aqueduct.

2. Shielded cable for permanent reference electrode

a) #14 HMWPE.

3. Pipeline leads:

a) Shop-connect leads to the steel strap core with silver solder for pipeline connection.

4. Underground marking tape:

a) Polyethylene.

b) Yellow.

c) 6 inches wide.

d) Black lettering.

e) Continuous message that reads: "CAUTION - CATHODIC PROTECTION LINE BURIED BELOW."

B. Magnesium Anodes

1. Anode ingots:

a) Cast with a perforated galvanized steel strap core.

b) Recess one end of anode so that one end of strap is accessible for lead wire connection.

2. Insulate connections in factory with electrical potting compound recommended by anode manufacturer to prevent intrusion of moisture.

3. Anode leads:

a) Factory installation of anode leads prior to shipment shall conform with the following requirements:

(1) One continuous length without splices from the anode connection to the respective test stations.

(a) If lead is damaged, replace wire and anode

(2) Ship anode leads with the attached anode to Site with wire wound on a reel. Minimum core diameter of reel shall be 6 inches. Bends shall have minimum 2 1/2 inches radius.

4. No splices shall be allowed between the anode connection and the pipe or test station.

5. Prepackage anode in permeable cloth bag containing a low resistivity backfill consisting of 75 percent ground hydrated gypsum, 20 percent powdered bentonite and 5 percent anhydrous (sodium sulfate).

6. Magnesium anodes:

a) 60 pounds.

b) Composition: standard alloy Grade C as described below:

Element	Minimum Percent	Maximum Percent
Aluminum	--	0.010
Manganese	0.5	1.3
Copper	-	0.02

Element	Minimum Percent	Maximum Percent
Nickel	-	0.001
Iron	-	0.03
Other		0.300 total or 0.05 each
Magnesium	Remainder	Remainder

C. Test Stations for Pipeline

1. Types:

   a) Type A (anode and test station)

   b) Type B (insulated flange, anode, and test station on valve and pipeline)

   c) Type C (blowoff assembly)

2. Manufacturers:

   a) Cott, Flush Fink model

   b) Tinker & Rasor

   c) Or Approved Equal

3. Mounting pipe: Schedule 40 galvanized steel as indicated.

4. Terminal boards for test stations:

   a) Reinforced phenolic plastic,

   b) or approved equal.

   c) Sized as indicated.

5. Double-nut bolts, washers, and all hardware:

   a) Brass

   b) Factory-install on terminal boards as indicated.

6. Nameplates: Factory-mount inside each test station on terminal board as indicated.

7. Shunts:

   a) Calibrated 0.01-ohm manganin wire.

   b) 5-amp capacity.

   c) Accuracy: plus or minus one percent.

   d) Shunt manufacturers:

      (1) Holloway

      (2) Cott

      (3) Or Approved Equal

8. Test station color: Orange.

D. Insulating Flange Kit for Pipeline

1. Each insulating flange kit shall consist of:

   a) a full-faced central insulating gasket.

   b) a full-length insulating sleeve for each flange bolt.

   c) two insulating washers with two steel washers for each bolt.

2. Ring-type central insulating gasket:

   a) 1/8-inch thick sheet packing

   b) Dielectric constant: high.

   c) Mylar insulating sleeves

3. Stainless steel washers:

   a) fit well within the bolt facing on the flange

4. Insulating washers:

   a) fabric-reinforced phenolic resin

   b) shall fit within the bolt facing the flange over the outside diameter of the sleeve.

5. Complete assembly:

   a) Pressure rating equal to that of the flanges between which flange kit is installed.

E. Dielectric Blankets and Sleeves/Wraps

1. Dielectric Blankets shall consist of ¼ inch thickness of one of the following materials:

   a) butyl Rubber

   b) PVC

   c) HDPE

   d) Neoprene

   e) or approved equal

2. Sleeves or wraps shall consist of ¼ inch thickness of one of the following materials:

   a) phenolic plastic

   b) fiberglass sheet

   c) or approved equal

PART 3 EXECUTION

3.01

A. Corrosion Monitoring System for Pipeline

1. Installation of anodes and reference cells:

   a) Remove plastic or paper bags from prepackaged anodes before lowering into hole.

   b) Do not suspend anodes by lead wires.

   c) Install prepackaged anodes as indicated.

   d) Place anode at each insulating flange joint and valve locations.

   e) Do not bury anodes until Owner has inspected placement of anodes and given permission to backfill.

   f) Backfill with native soil, compacted in 6-inch lifts.

g) Compact soil around anode during each lift until backfill has reached grade.

h) When compacted soil has been placed to the top of the anode, pour water into the hole to saturate anode packing and surrounding soil.

i) Anodes placed in violation of this Section 13110 will be rejected.

j) If damage occurs to the canvas bag enclosing anode and packing material, anode-to-lead connection, copper wire, or wire insulation, replace entire assembly.

k) Install anode lead wires as indicated and attach to panel board in test station.

2. Silver solder connections to pipeline:

a) Remove concrete mortar from surface of pipe over an area just sufficient to make the connection.

b) Clean surface of pipe to white metal by grinding or filing prior to soldering conductor. Resin-impregnated grinding wheels will <u>not</u> be allowed.

c) Remove enough insulation from conductor to solder conductor to pipe.

d) Silver solder connections to pipeline as indicated.

e) After solder has cooled, remove all slag, and test metallurgical bond for adherence to substrate.

f) Cover all exposed surfaces of copper and steel with insulating materials.

g) Before application of coating, dry all surfaces and clean free of oil, dirt, loose particles and all other foreign matter.

h) For cement mortar-lined and coated pipe, match coating over connection with exterior mortar.

i) Apply coating to all exposed metal on pipe and conductor at silver solder locations per manufacturer's recommendations.

j) Do not bury connections to structures or piping until Owner has inspected the connections and given permission to backfill. Connections made in violation of this provision will be rejected.

3. Installation of leads for pipeline:

   a) Clear bottom of finished trench free from stones, roots or other materials that may injure insulation of conductors.

   b) Install wires in conduit buried in the ground straight, without kinks, with a minimum cover of 24 inches.

   c) Install underground marking tape above buried wire and conduits at a maximum depth of 18 inches below grade over the wire and conduit location.

   d) Place anode wire identification tags on wires prior to placing wire in conduit and prior to backfilling.

   e) Run each conductor length continuously, free of joints or splices, unless otherwise indicated.

   f) Use care during installation to avoid punctures, cuts and similar damage to insulation. If any damage occurs to insulation, replace entire cable length.

   g) Leave at least one foot of slack for each conductor at each test station housing. Slack shall be that amount of wire which, when the cover is removed and the wire extended, protrudes beyond the opening of the box or enclosure.

   h) Wire bends shall not exceed bend radius stated in NEC or as specified by manufacturer.

   i) Use copper or brass terminal rings sized for wire and stud to make all wire connections to terminal studs.

   j) During installation, do not pull wire beyond its tensile strength as specified by manufacturer.

4. Installation of test stations:

   a) Install test stations at the approximate locations as indicated and to the side of roads, if located in a road.

   b) Install using applicable equipment specified for anodes and pipeline, and at dielectric insulation pipe flanges and valve connections as indicated.

   c) Place post-mounted test stations as close to pipeline in graveled areas where possible and away from roads subject to vehicular traffic.

d) Place flush-mounted concrete box test stations as close to pipeline as practical, as approved by Owner, if subject to vehicular traffic.

e) Field verify final locations of the test stations with Owner.

f) Place wire identifiers on all wire prior to installation and backfill of test stations.

5. Installation of dielectric blankets:

a) Install dielectric blankets at the approximate locations as indicated.

b) Dielectric blanket shall be installed as close to the midpoint between the two lines as possible.

6. Installation of sleeves or wraps for electrical isolation between pipelines:

a) Prevent electrical contact of the pipeline to other buried metal structures.

b) Insert a 1/4-inch thick material to prevent contact between the structures.

c) Where pipeline is within 5 feet of a small foreign metal structure, install a sleeve or wrap to prevent contact between structures.

7. Joint bonds:

a) Provide bonds on:

(1) all buried iron-based metallic pipe to and across all mechanical joints.

(2) any joint not welded or threaded.

(3) elsewhere to provide electrical continuity in exposed areas during construction.

b) Install to allow for at least two-inch movement in the pipe joint.

c) Attach cable/rod by soldering.

d) Provide at least two bonds.

B. Testing

1. After entire cathodic protection Work is installed, conduct tests to demonstrate that installation is in proper working order and in accordance with the Contract Documents.

2. Bear costs of retesting occasioned by defects and failures of equipment to meet the requirements of the Contract Documents.

3. Prior to backfilling, test silver solder connections for:

   a) adherence to pipe.

   b) electrical continuity between pipe and leads.

4. Use a 22-ounce hammer for testing adherence by striking a blow to the weld.

5. Avoid hitting leads and damaging pipe.

6. Measure and record anode current for pipeline:

   a) Measure current output of anodes at each anode test station across the permanent shunts.

   b) Record current and submit for review and acceptance by Owner.

7. After installation, and prior to backfilling:

   a) Circulate current through pipe and valve connections.

   b) Compare measured resistance to the theoretical resistance of pipe and bond cables.

   c) Resistance measured shall not exceed 150 percent of the theoretical resistance.

8. Upon completion of backfilling operations, test all joint bonds for effectiveness.

9. Place insulating joints on pipelines immediately inside structures.

10. Conduct testing with insulation checker:

    a) Manufacturers for insulation checker:

       (1) Gas Electronic, Model #601

       (2) Tinker & Rasor RF-IT

(3) Or Approved Equal

b) Test parameters:

(1) Insulating flanges must not be less than 100 percent insulation.

c) Upon completion of backfilling operations, re-test insulating flange kits for effectiveness.

d) Conduct testing by measuring half-cell potentials at either side of the flange kit, or other means, as necessary to confirm that the flange kit was not damaged by backfilling.

e) For any non-functioning insulating flange or insulating coupling, correct non-functioning part.

11. Conduct structure-to-soil potential tests on anodes prior to their connection to the pipeline to ensure that the proper anode material is provided.

a) Anode-open circuit potential shall be more negative than –1600 millivolts (mV) with respect to the anode.

12. Prior to and after leak test, test dielectric insulation fittings per NACE Standard RP0286 to ensure their proper installation. Backfilling is allowed after leak test.

13. Conduct a post-installation survey consisting of the following tests as a minimum:

a) Pipe-to-soil potentials at test stations.

b) Anode current outputs at test stations.

C. System Checkout

1. Upon completion of installation, provide testing of the complete systems.

a) The system must comply with NACE RP0169

2. In presence of Owner, conduct measurement of:

a) potentials of metallic piping and fittings prior to and after connection of anodes

b) current readings

3. Correct any non-functioning insulating flange and insulating coupling deficiencies and rectifier deficiencies.

4. A factory-authorized Technical Representative shall approve the final installation and start-up of the cathodic protection installation.

5. Retest prior to Final Acceptance.

END OF SECTION

SECTION 13300
INSTRUMENTATION AND CONTROL GENERAL

PART 1 – GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes the general specification and requirements for the instrumentation and control WORK under this and other applicable Specifications. The WORK also includes providing instrumentation and all related wiring as shown in these Contract Documents.

B. The CONTRACTOR shall provide (furnish and install), test, and place into service the operating process instrumentation, control systems, and all appurtenant work, all in accordance with the requirements of the Contract Documents. The Contractor shall procure equipment and obtain the services of a qualified Control System Supplier.

C. Systems specified as a part of Division 13 shall be furnished, manufactured, wired and tested as a complete system by a qualified Control System Supplier (CSS). The CSS shall provide all equipment, materials, instrumentation and assemblies complete. The CSS shall provide, but not necessarily be limited to, installation coordination, factory testing, configuration testing, system commissioning and final acceptance.

D. The CSS shall be responsible for the detailed design, procurement, installation coordination, testing, commissioning, training, and documentation of electrical, instrumentation and control systems provided under this Contract.

E. The CSS shall be responsible for interfacing with the Owner's Supervisory Control and Data Acquisition (SCADA) communications. The CSS shall provide all hardware, test software, installation, factory testing, commissioning and training for new system. The CSS shall coordinate all field and point testing with the local Programmable Logic Controller (PLC) programming and SCADA configuration applications to verify all I/O.

F. The Contractor shall note that the equipment loop, logic, system, PLC and elementary diagrams are not manufacturer, model or part # specific and are based on non-certified, owner, packaged system supplier and vendor information to indicate a general scope of supply from the Equipment Manufacturers. The specifications address functional requirements, features and operation that may require additional options or components from the Contractor to provide for a complete and functional system.

G. The CSS shall coordinate all requirements with the equipment manufacturers suppliers at bid time to provide for a complete and operable system and shall include all costs in its bid to add additional instruments, wiring, computer inputs/outputs, controls, conduit, interlocks, electrical hardware, drawing revisions etc., into the design based on Equipment Manufacturer's requirements

and final certified prints to meet the specifications. Such changes to instrumentation and electrical work to meet the specification requirements shall be incorporated into the scope of work at no additional cost to the Owner.

H. Per specified submittal requirements the CSS shall be responsible for the generation of panel wiring diagrams equipment interconnection diagrams, network diagrams and loop drawings which depict the interconnection between instruments, control panels, field panels, electrical equipment, control equipment, motorized equipment, existing systems, packages systems and MCCs.

I. The CSS shall generate a complete analog and digital loop drawing for each measuring and/or control loop. The loop drawing shall include information as specified in the submittal requirements for loop drawing preparation.

J. All control system field tests including factory tests, loop tests, site commissioning, operational readiness testing, plant startup, and final acceptance shall be the responsibility of the Contractor. The Contractor shall be responsible for providing field and facility personnel to perform factory and field testing of all systems. The Contractor shall be responsible for providing all personnel and equipment (current drivers, jumpers, read out devices, oscilloscopes, voltage-resistance meters, etc.) required to perform the loop test simulations. All devices used shall be traceable to the National Institute of Standards and Technology (NIST).

K. The Contractor shall perform field engineering as required for mounting and supporting all field mounted components. The Contractor shall develop any additional schematic and interconnection diagrams required to interface with existing systems, PLC and instrumentation equipment, which may be required for a complete and operable instrumentation and control system.

L. The CSS, shall procure, fabricate, assemble, program and configure the instrumentation and control system based on the requirements of Divisions 13, 16, and related Mechanical and Civil Divisions.

M. Instrumentation materials, process wetted parts and installations shall be designed to be compatible with the process media, area environment and classification in which it shall operate.

N. Instrument installation shall provide for unobstructed access to the instruments for calibration, diagnostics and process display. Instrumentation displays shall be protected from direct sunlight exposure and shall be provided with sunshields as required to provide legible display viewing during daylight hours at a 24" viewing distance.

O. The CSS shall design, procure, program, factory test, install, commission and support a PLC system that shall integrate all process controls required to provide for a complete and operational system. The PLC system shall be designed in accordance with Owner standards for SCADA and PLC systems. The CSS shall

coordinate the I/O grouping and arrangement with the Owner during the submittal process.

P. The CSS shall field verify all existing instrumentation and logic systems prior to implementing the specified modifications. The operation of switches and interlocking logic shall be confirmed to operate in either the Normally Open or Normally Closed states. The Contractor shall provide interposing relays and wiring modifications necessary to meet the operational requirements specified.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK with respect to interfacing electrical, instrumentation and control systems packaged under the mechanical and civil specification sections.

B. Division 16 Electrical

C. Division 13 Special Construction

D. Division 1

1.3 CODES

A. WORK of this Section shall comply with the current editions of the following codes:

1. Uniform Fire Code
2. National Electrical Code
3. California Electrical Code
4. City of Palo Alto Service and Electrical Requirements

1.4 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the current editions of the following apply to the WORK of this Section:

1. ISA-RP60.6 Nameplates, Labels, and Tags for Control Centers

2. ISA-RP12.6 Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations

3. ISA-S5.1 Instrument Symbols and Identification

4. ISA-S5.4 Instrument Loop Diagrams

5. ISA-S20 Specification Forms for Process Measurement and Control Instrumentation; Primary Elements and Control Valves.

1.5 SUBMITTALS

A. Submittals shall be supplied in accordance with Division 0 and 1 specifications and as supplemented or modified by this specification section.

B. Control panel submittals

1. Control panel submittals shall be grouped by location, area and process. Bill of Materials and fabrication drawings shall be individually grouped by facility, area and control panel.

2. A separate technical brochure or bulletin shall be included for each instrument, and equipment item, system, and other element. The brochures shall be indexed by systems or loops. If, within a single system or loop, a single item is employed more than once, one brochure may cover all identical uses of that item in the system. Each brochure shall include a list of tag numbers to which it applies. System groups shall be separated by labeled tags.

3. Schematic and wiring diagrams for control circuits shall be submitted in two stages. Initially, schematic control diagrams shall show complete details on the circuit interrelationships of all devices within and outside each Control Panel. Subsequent to acceptance of all schematic control diagrams, by the Engineer, piping and wiring diagrams shall be submitted. The diagrams shall consist of component layout drawings to scale, showing numbered terminals on components together with the unique number of the wire to be connected to each terminal. Piping and wiring diagrams shall show terminal assignments from all primary measurement devices, such as flow meters, and to all final control devices, such as pumps, valves, chemical feeders and local control panels. Wiring diagrams shall include MCC Panel, circuit, and breaker number for each power feed.

4. Assembly and construction drawings for each alarm annunciator, local indicating panel, process control panel and for other special enclosed assemblies for field installation. These drawings shall include dimensions, identification of all components, surface preparation and finish data, and nameplates. These drawings also shall include enough other details, including photographs, to define exactly the style and overall appearance of the assembly; a finish treatment sample shall be included.

5. Installation, mounting, and anchoring details for all components and assemblies to be field-mounted, including conduit connection or entry details.

6. Complete control panel layouts, all drawn to a 1-1/2 inch=1 foot scale showing:

a. Physical arrangements which define and quantify the physical groupings of PLC components, annunciators, handstations, recorders, indicators, pilot lights and all other instrumentation devices associated with control panel sections, auxiliary panels, subpanels and racks.

b. All cutout locations fully dimensioned.

c. All outside panel dimensions shall be shown.

d. Locations of back-of-panel stiffeners.

e. Backpanel equipment layout and terminal point locations for all panel and back-of-panel piping and wiring connections. Terminations shall be coded with identifiers for wiring and piping connections for all electric, hydraulic and pneumatic terminations.

7. Bill of Material:

a. A complete and detailed bill of material list shall be submitted for each field mounted device or assembly as well as cabinet assemblies and subassemblies. Bills of material shall include all items within an enclosure. An incomplete submittal shall be rejected and no further evaluation performed until a complete and detailed bill of material is submitted.

8. Panel Power Calculations: Provide local calculations and back-up power capacity for all DC power supplies and Uninterruptible Power Systems (UPS). Power requirements shall state required voltages, currents, and phases.

9. Cooling and Heating: Provide heating and cooling calculations. Calculations shall include heat dissipation, and operating temperature. Heat dissipation shall be at maximum and shall be stated in BTU per hour or watts. Operating temperature shall be calculated at specified ambient temperatures or at 40 degrees C, if no other ambient temperature is specified. If ventilation fans are used, provide audible sound level for the fans.

1.6 FIELD INSTRUMENTATION

A. Instrumentation Summary/Schedule and Bill of Material

B. Technical brochures, bulletins and data sheets containing:

1. Fully completed ISA S20 data sheets

2. Technical Specification Data Sheets

3. Component functional descriptions

4. Locations or assembly at which component is to be installed

5. Materials of a component's parts which will be in contact with process fluids or gases

C. Instrumentation Loop Diagrams per ISA S-5.4

1.7 PLC CONFIGURATION

A. The CSS shall provide a SCADA I/O database referencing all PLC I/O points, internal registers accessed by the SCADA and associated PLC setpoints. The Database shall utilize the same format and structure utilized by the City in an Excel Spreadsheet.

B. Programming of the PLC shall utilize the same methods, procedures and format as that of existing PLC programs to maintain program uniformity.

1.8 SCADA CONFIGURATION

A. The CSS shall coordinate with Owner staff who are performing the SCADA programming and configuration to insure that the system I/O, Internal Registers and communications protocols are consistent with the requirements for SCADA monitoring and control.

1.9 SYSTEM START-UP AND COMMISSIONING

A. The CSS shall provide comprehensive-testing procedures, forms and reports complete. Testing submittals shall address the testing and commissioning requirements of Divisions 13, and 16.

1.10 PROJECT MEETINGS

A. Attend meetings as specified.

1.11 OWNER'S MANUAL

A. Information included in the OWNER'S MANUAL shall comply with the requirements of specifications with the following exceptions:

1. Two copies of the OWNER'S MANUAL shall be submitted after acceptance of all submittals under Paragraph 1.5. One set will be returned to the CONTRACTOR with comments.

2. Final copies (6) of the OWNER'S MANUAL, after revision, shall be submitted to the ENGINEER 15 days prior to startup.

3. The following shall be included in the OWNER'S MANUAL:

a. Installation, connection, operating, troubleshooting, maintenance, and overhaul instructions from the manufacturer.

b. Exploded or details views of all instruments, assemblies, and accessory components.

c. Parts lists and ordering instructions.

d. Wiring diagrams.

e. A list of spare parts for 1 year operation recommended by the manufacturers of all analog equipment.

1.12 AS-BUILT DRAWINGS

A. As-built drawings shall be prepared in accordance with Division 0 and 1.

1.13 COORDINATION

A. The CSS shall coordinate protective circuit requirements with the instrumentation and valve actuator suppliers. The CSS shall install and wire, pump supplier furnished protective circuitry in accordance with the manufacturers requirements.

1.14 SERVICES OF MANUFACTURER

A. Calibration, Testing and Startup: The contractor shall provide the services of technical service representative of the manufacturer who shall visit the site and perform the following on all flow meters and chemical system analyzers.

1. Inspection, checking and calibrating the equipment.

2. Startup and field testing for proper operation.

3. Performing field adjustments to ensure that installation and operation comply with the Specifications.

B. Instruction of OWNER'S Personnel: The manufacturer's technical service representative shall instruct the OWNER'S personnel

1.15 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Delivery of Materials: Products delivered to the site for incorporation into the WORK of this Section shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.

B. Storage: Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.

C. Installed Equipment: Equipment installed in place for periods exceeding 24 hours prior to the field wiring and commissioning of electrical and electronic equipment shall be protected from dust and exposure to the elements.

D. Shipment: Panels shall be crated for shipment using a heavy framework and skids. Panel sections shall be cushioned to protect the finish of the instruments and panel during shipment. Instruments, which are shipped with the panel, shall have suitable shipping stops and cushioning material installed to protect instrument parts from mechanical shock damage during shipment. Each panel crate shall be provided with removable lifting lugs to facilitate handling.

1.16 ENVIRONMENTAL CONDITIONS

A. General: All instrumentation and control system components and associated wiring shall be suitable for use in an environment where there may be high energy AC fields, DC control pulses, and varying ground potentials between transducers and system components. The system design shall be adequate to provide proper protection against interferences from all such possible situations.

B. Field Located Equipment: The system design shall be adequate to provide proper protection in the environment typically associated with these facilities. As a minimum, the instrumentation and control systems shall be designed and constructed for satisfactory operation and low maintenance requirements under the following environmental conditions:

1. Temperature Range: 0 through 60 degrees C (32 - 144 degrees F)

2. Thermal Shock: 0.55 degrees C per minute (1.0 degrees F per minute)

3. Relative Humidity: 20 - 95 percent (non-condensing)

C. Noise Tolerance: The instrumentation and control system components shall not exceed a db level of 55 when monitored 3-feet away from the devices. If upon testing it is found that this limit is exceeded at the option of the ENGINEER and at no additional cost to the OWNER, devices shall be replaced in order to achieve a maximum level of 55 db or sound absorption materials shall be added.

1.17 CABLE NUMBERING

A. All cables and conductors shall be provided with a unique cable identifier.

B. The first characters shall denote the facility or area number.

C. The second group of characters identifies the field device being served ISA or equipment tag reference.

D. The third section is the loop or equipment number.

E. The fourth section uses one of the four suffixes in the table below. Where multiple circuits of the same type are routed to the same endpoint, the suffix will be P1, P2, as required.

F. At each device or termination point, the circuit identification number is appended with the individual wire number. For Direct Current (DC) circuits only, wire polarity is shown in parentheses as (+) or (-). Spaces are not allowed, and letters are not case-sensitive, and written in upper case.

SUFFIX	CIRCUIT TYPE	EXAMPLE
(S) - Signal	24 v dc analog (4-20 mA)	FIT2101S1+
(C) – AC Control	120 volt AC control	YIA2101C2
(D) – DC Control	24v dc digital status or control	LSH2101D1+
(P) – Power	Power (480 v, 5 kv, 15 kv, etc.)	RWP2101P2
(L) – Power	Power (120/240 volt)	RWP2101P2
(T) - Communications	Communications	FON2101T2

1.18 GENERAL

A. All meters, all instruments, and all other components shall be of the most recent field-proven models marketed by their manufacturers at the time of submittal of the shop drawings unless otherwise indicated.

B. Outdoor instrumentation shall be suitable for operation in the ambient conditions at the equipment installation locations. Heating, cooling, and dehumidifying devices shall be incorporated with the outdoor instrumentation in order to maintain it within its rated environmental operating ranges.

C. The Contractor shall provide all power wiring for these devices.

D. Outdoor enclosures suitable for the environment shall be provided at the specified locations.

E. All instrumentation in hazardous areas shall be intrinsically safe or be approved for use in the particular hazardous classification in which it is to be installed.

F. Mercury switches and components containing liquid mercury shall not be used.

G. Analog measurements and control signals shall be electrical and shall vary in direct linear proportion to the measured variable, except as indicated. Electrical signals outside control board(s) shall be 4-20 mA DC except as noted. Signals within enclosures shall be 1-5 volts DC unless otherwise specified. Dropping resistors shall be installed at all panel side terminations in the control panels to ensure loop integrity.

H. The accuracy of each instrumentation system or loop shall be expressed as a probable maximum error; this shall be the square-root of the sum of the squares

of certified "accuracies" of the designated components in each system, expressed as a percentage of the actual span or value of the measured variable. Each individual instrument shall have a minimum accuracy of ± 0.5 percent of full scale and a minimum repeatability of ± 0.25 percent of full scale unless otherwise indicated. Instruments that do not conform to or improve upon these criteria are not acceptable.

I. Each control loop shall be individually fused.

1.19 INSTRUMENTATION AND CONTROL PANELS

A. General:

1. Control panels shall be provided as specified in Section 13340.

2. Equipment Framework and Supports:

a. The rear of each control panel section or Instrument wall panel shall have a steel framework for supporting conduit, tubing, wireways, switches, air piping and all instrument accessory items such as relay or terminal enclosures, transducers, pressure switches, valves and air relays. The main frame work shall be constructed of standard structural shapes. Special shapes such as "Unistrut" may be used for secondary supports. Framework must not interfere with instrument connections or access needed for maintenance or adjustments.

b. Preparation: The front and rear face of the panel, both sides and the edges of all flanges, and the periphery of all openings shall be prepared as follows:

1) All high spots, burrs, and rough spots shall be ground smooth.

2) The surfaces shall be sanded or sandblasted to a smooth, clean bright finish.

3) All traces of oil shall be removed with a solvent.

c. Finishing:

1) A 3-mils dry coat of Amercoat 185 or equal primer shall be applied over the entire panel surface immediately after solvent cleaning.

2) Wet sand, dry, and then quick glaze spot putty on the front of the panel only. Dry, then wet sand again and dry.

3) Apply a second 3-mils dry coat of alkyd enamel primer to the front of the panel.

4) Wet sand to smooth clear finish, and then dry.

5) At least two 3-mil dry coats of air-dry, satin finish, alkyd enamel shall be applied over the entire surface. Color to be as selected by Owner.

6) The CONTRACTOR shall furnish two 1-pint containers of the enamel to the Owner.

1.20 INSTRUMENT MOUNTING

A. The Contractor shall provide field cut-outs, installation mounting racks, mounting brackets, bracing, shelving and stanchions, and shall mount all instrument and control items indicated, including any instruments indicated to be furnished by the Owner or other manufacturers.

B. The Contractor shall also mount, behind existing panels, other instrument accessory items as indicated or necessary for interfacing with existing equipment.

C. Control Panel Requirements:

1. Controls panels shall be wired and fabricated in accordance with section 13340.

2. Field modifications of existing panels shall adhere to the requirements of section 13340.

3. The Contractor shall provide all wiring, conduit, wireways, and switches required to make instruments and other panel electrical devices operational.

4. Conduit, wireways, junction boxes and fittings shall be installed for all signal and control wire. Provide in accordance with Division 16.

5. Each terminal connection shall have a plastic plate with a terminal and instrument tag number. All wiring shall be identified with stamped tubular heat shrink wire markers.

6. Unless otherwise specified, wiring methods and materials for all panels shall be in accordance with the NEC requirements.

7. Wire for 115-volt control circuits shall be No. 14 AWG stranded with Type THWN/THHN insulation. All terminals for external wiring connections shall be suitable for No. 10 AWG wire.

8. Flexible conduit shall be utilized only for short transitions (36”) from instrument or equipment.

9. Conduit fittings shall be cast fittings.

10. Soldered or pressure crimped wire splicing in conduits shall not be acceptable.

11. For case grounding, panels shall be provided with a 1/4-inch by 1-inch copper ground buss completed with solderless connector for one No. 4 AWG bare stranded copper cable. The Contractor shall connect the copper cable to a system ground loop.

D. Instrumentation Requirements:

1. Instruments located on a single panel section that serve one process unit may be connected to a common branch power circuit. The number of branch circuits shall be such that no circuit load exceeds 10 amps. Different panel sections and instruments serving different process units shall not use common branch circuits. A 15-amp, two-pole circuit breaker shall be provided in each branch circuit.

2. When instruments not equipped with integral fuses, the contractor shall furnish and install fuses as required for the protection of individual instruments and equipment against fault currents. Fuses shall be mounted on the back of the panel, in a fuseholder, with each fuse identified by a service name tag.

3. Each potentiometer type instrument, electronic transducer, controller or analyzer shall have an individual disconnect switch. Disconnect switches shall have metal or plastic tags listing the associated instrument tag numbers. Individual plug and cord set power supply connections may be used without switches when indicated.

E. Field Signal Wiring:

1. Signal cable shall be constructed of No. 16 AWG copper signal wires with THWN insulation.

2. Control conductors shall be 14 AWG minimum routed in conduit or troughs. Control conductors shall be THWN insulation.

3. Wire color code for instrument signal wiring shall be:

a. Positive - White (+)

b. Signal Ground Negative - Black (-)

c. Equipment Ground – Green

d. Ungrounded – Red

e. Energized by voltage found external to panel – Yellow

f. DC circuit - Blue

g. Control – Violet

4. Multi-conductor signal cables where indicated shall consist of No. 16 AWG copper signal wires twisted in pairs, with 300 volt insulation. A copper drain wire shall be provided for the bundle with a wrap of aluminum polyester shield. The overall bundle jacket shall be PVC. Multi-conductor cables, wireways and conduit shall provide for 20 percent allocation of spare, unused signal wires in addition to the indicated requirements.
5. Remote I/O (RIO) and Modbus Plus (MB+) cabling shall be provided, installed and terminated in accordance with the manufacturers cabling and termination procedures.

F. Color Conventions: Lens covers/LED's for indicating lights on all panels will be colored as follows:

1. Red-ON when;

a. Motor not running (STOPPED)

b. Valve CLOSED (not fully opened)

c. Device not energized.

d. Circuit breaker OPENED

2. Green-ON when;

a. Motor running in forward direction (fast speed for multi-speed motors).

b. Valve OPEN (not fully closed)

c. Device energized.

d. Circuit breaker CLOSED

3. White-ON when;

a. Power available

b. System in AUTOMATIC mode.

c. Monitoring taking place.

4. Amber-ON when;

a. Malfunction trip.

b. Equipment locked out.

c. Alarm condition

1.21 NAMEPLATES

A. Nameplates shall be provided for instruments, function titles for each group of instruments, and other components mounted on the front panel(s) as indicated. A nameplate shall be provided for each signal transducer, signal converter, signal isolator, and electronic trip mounted inside the panel(s). Nameplates shall be descriptive to define the function and system of such element. These nameplates shall be of the same material as those on the front of the panel(s). Adhesives shall be used for attaching nameplates. Nameplates shall be fabricated from black face white-center laminated engraving plastic. Painted surfaces shall be prepared to allow permanent bonding of adhesives. Colors, lettering, styles, abbreviations and sizes shall be in conformance with ISA_RP60.6 with an intended viewing distance of 3 feet to 6 feet.

B. Equipment Interior Nameplates - Nameplate material shall be clear plastic with black machine printed lettering as produced by a KROY or similar machine; except caution, warning, and danger nameplates shall have red lettering. The size of the nameplate tape shall be no smaller than 1/2" in height with 3/8" lettering unless otherwise approved by the Engineer. Securely fasten nameplates in place on a clean surface using the adhesion of the tape. Add additional clear glue to hold the nameplate securely in place when necessary. For each device with a specific identity (relay, module, power supply, fuse, terminal block, etc.) mounted in the interior of a piece of equipment provide a nameplate with the inscription as shown in the Contract documents. Where no inscription is indicated in the Contract documents, furnish nameplates with an appropriate inscription providing the name and number of device used on the submittal drawings. Stamp the nameplates with the inscriptions as approved by the Engineer in the submittal.

PART 2 – PRODUCTS

2.1 GENERAL

A. Equipment and materials shall be products of reputable, experienced manufacturers. Similar items in the project shall be the products of the same manufacturer. All equipment shall be of industrial grade, a standard of construction, shall be of sturdy design and manufacture, and shall be capable of long, reliable, trouble-free service.

B. The field equipment panels shall be fabricated to house, controllers, instrumentation and communications equipment specified elsewhere and as indicated on the contract drawings.

C. Instrumentation control equipment shall be UL listed.

2.2 FIELD INSTRUMENTATION

A. Provide Field Instrumentation in accordance with Section 13330, Instrumentation.

2.3 COMPONENTS GENERAL

A. Field Terminal Blocks: Terminal blocks shall be molded plastic with barriers and box lug terminals, and shall be rated 25 amperes at 600 volts. White marking strips, fastened securely to the molded sections, shall be provided and wire numbers or circuit identifications shall be marked thereon with permanent marking fluid.

B. Indicators: Indicators shall be provided at the locations specified and shall be rated for the voltage required. Indicators shall be full-voltage Push-To-Test LED.

2.4 GENERAL INSTRUMENTATION AND CONTROL COMPONENTS

A. General instrumentation components shall be provided as specified in Section 13330 Instrumentation.

B. Signal Isolators, Converters, and Power Supplies: Signal isolators shall be provided in each measurement and control loop, wherever required, to match adjacent component impedances, provide signal amplification, or where feedback paths may be generated or to maintain loop integrity when the removal of a component of a loop is required. Signal converters shall be provided where required to resolve any signal incompatibilities. Signal power supplies shall be provided to supply sufficient power to each loop component.

C. Power supply and conversion modules shall be supplied as required to provide the required equipment operational voltage and current. Power supplies shall be sized to provide 125 percent of the maximum current requirements.

D. General Purpose Relays: General purpose relays in the Control Panels shall be plug-in type with contacts rated 10 amperes at 120 volts ac; quantity and type of contacts shall be as indicated. Each relay shall be enclosed in a clear plastic heat and shock resistant dust cover with LED status indicator. Sockets for relays shall have screw type terminals.

E. Industrial Control Relays: Industrial control relays shall be 20 Amp rated with four-pole convertible contacts. The coil voltage shall be as required to interface with the required control logic. The ICR shall be capable of providing eight contacts with the addition of a four-pole module mounted to the deck assembly.

F. Time Delay Relays: Time delay relays shall be electronic on-delay or off-delay type with contacts rated 10 amperes at 120 volts AC. Units shall include adjustable dials with graduated scales covering the indicated time range. Timers shall be provided with status and timing LED indication.

G. Slave Relays: Slave relays shall be provided when the number or type of contacts indicated exceeds the contact capacity of the indicated relays and timers.

H. Circuit Breakers: Circuit breakers shall be single pole, 120 volt, 15 ampere (minimum) rating or as required to protect wiring and equipment. Circuit breakers shall be mounted inside the panels as shown.

PART 3 - EXECUTION

3.1 GENERAL

A. The CONTRACTOR shall employ qualified installers who are skilled and experienced in the installation and connection of all elements, all instruments, all accessories, and all assemblies provided under this Contract.

B. The CONTRACTOR shall install all instruments according to the manufacturer's installation instructions and provide the following:

1. Perform field engineering as required for mounting and supporting all field mounted components.

2. Prepare any additional schematic and interconnection diagrams required for installation.

3. Assemble and interconnect instrument components disconnected for shipping purposes.

4. Remove all temporary supports, bracing, and padding inserted in instrument control panels and other equipment to prevent damage during shipping, storage, or installation

3.2 PROCESS TUBING AND PIPING

A. The CONTRACTOR shall provide for all chemical sample piping and chemical analysis system piping/tubing installations in accordance with Owner standards. All flow thru, tee and insertion instrumentation sensors shall be installed with hot-tap assemblies or valving systems that allow the instrument to be removed from the system without disruption of the process.

B. Adequately support and protect capillary tubing. All extra tubing shall be carefully coiled, tied, and protected at the instrument location.

C. Instrument tubing and conduit shall be installed level and parallel with, or at right angles to, the structural members of buildings and support systems. Vertical runs shall be straight and plumb and installed with adequate strain relief to prevent damage and separation of tubing and tubing support systems.

D. All tubing installations shall allow clear and unobstructed access to equipment, doorways, controls, control panels, and field devices. Tubing and conduit installations shall allow easy removal of components or equipment. Components in tubing, but shall be separately supported by a specified wall or stanchion equipment mounting system.

E. All installations of piping, tubing, mounting hardware and equipment enclosures shall be field measured prior to fabrication and erection. Any significant discrepancies between drawings and field conditions shall be reported to the Engineer. The Owner will not be responsible for any costs to the Contractor for rework because of Contractor failure to take measurements prior to fabrication.

3.3 CONDUIT AND WIRE

A. It is the intent of the Contract Documents that all installation of conduit and wiring external to Control Panels is provided under the requirements of Division 16. Further, it is the general intent that all 4-20 mA signal circuits, process equipment control wiring, signal wiring to field instruments, and Control Panel input and output wiring, be provided under Division 16.

B. Wire terminations and installation integrity shall be verified and tested under Division 13.

C. The CONTRACTOR's attention is directed to the electrical and mechanical schematics and details of this project. Referral to these portions of the Contract Documents shall be required in order to understand the full intent and scope of work required.

D. Monitoring and control system configurations are diagrammatic only. Locations of equipment are approximate unless dimensioned on the drawings. The contractor shall determine exact locations and routing of wiring and cables, which shall be governed by structural conditions, physical interferences, area classifications and locations of electrical terminations on equipment.

E. All instruments shall be located and installed for ready access by the OWNER'S operation and maintenance staff. Instruments shall be installed with due regard for servicing and maintainability. The OWNER reserves the right to require minor changes in location of equipment prior to roughing without any additional cost to the OWNER.

3.4 FIELD SIGNAL AND CONTROL CIRCUIT WIRING

A. Wiring Installation: All wires shall be in plastic wireways except (1) field wiring, (2) wiring between mating blocks in adjacent sections, (3) wiring from components on a swing-out panel to components on the fixed structure, and (4) wiring to panel-mounted components. Wiring from components on a swing-out panel to other components on fixed panels shall be tied into bundles with nylon wire ties, and shall be secured to panels at both sides of the "hinge loop" so that conductors are not strained at the terminals.

B. Wiring to control devices on the front panels shall be tied together at short intervals with nylon wire ties and secured to the inside face of the panel using adhesive mounts.

C. Wiring to rear terminals on panel-mount instruments shall be in plastic wireways secured to horizontal brackets above or below the instruments in about the same plane as the rear of the instruments.

D. Wire Marking: Each signal, control, alarm, and indicating circuit conductor connected to a given electrical point shall be designated by a single unique number which shall be shown on all shop drawings. These numbers shall be marked on all conductors at every terminal using white numbered wire markers which shall be permanently marked heat-shrink plastic.

3.5 INSTRUMENT CABLE TESTS

A. General: The following tests shall be performed on each instrumentation and control system cable. All tests shall be end-to-end tests of installed cables with the ends supported in free air, not adjacent to any grounded object. All test data shall be recorded on forms, which are available from the Engineer. Complete records of all tests shall be made and delivered to the Engineer. The Owners Representative who witnessed the testing shall sign each form.

B. Continuity tests shall be performed by measuring wire/shield loop resistance of each signal cable as the wires, taken one at a time, are shorted to the channel shield. No loop resistance measurement shall vary by more than plus or minus 2 ohms from the calculated average loop resistance value.

C. Insulation resistance tests shall be performed by using a 500 volt megometer to measure the insulation resistance between each channel wire, between each channel wire and the channel shield, between individual channel shields in a multi-channel cable, between each individual channel shield and the overall cable shield in a multi-channel cable, between each wire and ground, and between each shield and ground. Values of resistance less than 1 megohms shall be unacceptable.

3.6 FACTORY OPERATIONAL READINESS TEST

A. Factory Inspection:

1. Instrumentation and control panels shall be inspected for compliance with requirements at the factory prior comprehensive system factory testing and before shipment to the site. The Contractor shall notify the Owner two weeks in advance of the testing date. The Owner or a representative of the Owner will visit the factory to make the inspection.

B. The Contractor shall perform the following tests prior to arrival of the Engineer:

1. All air lines adequately tested for leaks.

2. All control wiring and interlock circuits rung out to determine their operability.

3. Electrical circuits checked for continuity and where applicable, operability.

4. Nameplates checked for correct spelling and correct size of letters.

5. Other tests required to place the panel in an operating condition.

C. It shall be the responsibility of the Contractor to furnish all necessary testing devices and sufficient manpower to perform the tests required by the Engineer to determine conformance to the requirement of the Contract documents.

D. If the above tests have not been performed prior to the arrival of the Engineer, the Contractor shall reimburse the OWNER for the cost of the extra time required for the inspector's services and travel expenses

E. General: The complete control system shall be tested at the factory prior to installation of the PLC, communications and SCADA system. The Factory Operational Readiness Tests (FORT) for the entire system shall be conducted at the manufacturer’s facilities as a complete and operable system including the OIP and PLC’s.

F. The CSS shall provide the service of a licensed MCC SCADA systems integrator technician to setup, configure and test each system to verify equipment operation prior to the FORT. The technician shall be experienced in the programming, configuration and testing of PLC systems employing the communications protocols utilized. The CONTRACTOR shall coordinate all shipping, set-up, configuration and testing tasks related to the FORT. The OWNER and Engineer shall witness the FORT.

G. Tests shall be conducted to exercise all process variables and confirm setpoint trip points, process permissives, process interlocks, alarming and control functions. The CONTRACTOR shall provide the necessary personnel to operate,

test and confirm all PLC associated functions pertaining to graphical displays, setpoint interaction, PLC control strategies, alarm monitoring and manual control of the equipment.

H. The CSS shall prepare a FORT test procedure in the form of I/O checklists, calibration sheets for analog I/O and step by step process control strategy tests that exercise all normal, emergency and alternative control modes. I/O checklist shall reference each I/O by type, tag and description with a checkbox to verify PLC operation, Communication, DCS Display, Alarm Function and Command function with a comment field for testing notes.

I. Process control test forms shall be provided for each control strategy and subdivided into individual process loops and modes of operation contained within the process control strategy. The test procedure shall be provided on a step-by-step basis addressing each process on a loop-by-loop and function-by-function basis. A signature and comments box shall be provided for each procedure.

3.7 INSTALLATION

A. Installation and Connection:

1. The CONTRACTOR shall install and connect all field-mounted components, equipment enclosures and assemblies under the following criteria:

a. Process sensing lines and air signal tubing shall be installed to the installation of conduit indicated under Section 16050. Individual tubes shall be run parallel and near the surfaces from which they are supported. Supports shall be used at intervals not longer than 3 feet of tubing.

b. Bends shall be formed with the proper tool and to uniform radii and shall be made without deforming or thinning the walls of the tubing. Plastic clips shall be used to hold individual plastic tubes parallel. Ends of tubing shall be square-cut and cleaned before insertion into fittings. Bulkhead fittings shall be provided at all panels requiring pipe or tubing entries.

c. All flexible cables and all capillary tubing shall be provided in flexible conduits. Lengths shall be sufficient to withdraw the cables and tubing for periodic maintenance.

d. RTD/Thermocouple lead wire shall be provided in dedicated conduit or wireway from the thermocouple to the control panel. Conduit or wireway shall be sized in accordance with the capacity of the instrument.

e. All power and all signal wires shall be terminated with spade type lugs.

f. All connectors shall be, as a minimum, watertight.

g. After all installation and connections have been completed, a technical field representative of the CONTRACTOR shall check the WORK for polarity of electric power and signal connections, leaks at all process connections, and conformance with requirements. The technical field representative shall certify in writing to the ENGINEER that each loop and system meets requirements.

h. All wire and all cable shall be connected from terminal to terminal without splices, arranged in a neat manner and securely supported in cable groups. All wiring shall be protected from sharp edges and corners.

i. At least [30] days before installation testing begins, the CONTRACTOR shall submit to the ENGINEER a detailed description, in duplicate, of the installation tests to be conducted to demonstrate correct installation of the instrumentation and control system and the anticipated dates the testing will occur.

3.8 SYSTEM COMMISSIONING

A. Instrument Calibration

1. All analog and discrete instrumentation and all control system equipment shall be field calibrated and tested after installation to verify that requirements are satisfied. The CONTRACTOR shall provide all necessary labor, tools, and equipment to calibrate and test each instrument in accordance with the manufacturer's instructions. Each instrument shall be calibrated at a minimum of three points using test equipment to simulate inputs and read outputs.

2. All test equipment and all instruments used to simulate inputs and read outputs shall be suitable for the purpose intended and shall have accuracy better than the required accuracy of the instrument being calibrated. Test equipment shall have accuracies traceable to the NIST as applicable. All analog instruments shall be calibrated and tested in place without removal.

3. Test data, applicable accuracy requirements, all instrument manufacturer published performance specifications and all permissible tolerances at each point of calibration shall be entered on test forms available from the ENGINEER. These test forms shall verify compliance with all.

4. A calibration report shall be delivered to the ENGINEER for each instrument, certifying that the instrument has been calibrated in the presence of the Owners designated representative and meets contract and system requirements.

B. Point Testing

1. Analog Loop Tests: The CONTRACTOR shall be responsible for loop checking and testing all instrumentation loops with this project. The CONTRACTOR shall coordinate all loop check functions with the SCADA system, final element, PLC logic and intermediate equipment to ensure that a single total loop check is conducted. The intent of the loop checks is to confirm and document each loop's component specification conformance up to and including all field-situated devices.

2. The CONTRACTOR shall provide all control room personnel to witness and confirm loop check results at the SCADA display level.

3. The CONTRACTOR shall provide all necessary labor, tools, and equipment to field test, inspect and adjust each instrument to its indicated performance requirement in accordance with manufacturer's specifications and instructions. Any instrument which fails to meet any Contract requirement, or any published manufacturer performance specification for functional and operational parameters, whether or not indicated in the Contract Documents, shall be repaired or replaced, at the discretion of the ENGINEER at no additional cost to the OWNER.

4. Programmable Controllers, Operator Interface Units, and electronic function modules, shall be tested and exercised by the CONTRACTOR to demonstrate correct operation, first individually and then collectively as functional analog networks. Each hardwired analog control network shall be tested to verify proper performance within indicated accuracy tolerances. Accuracy tolerances for each analog network are defined as the root-mean-square summation of individual component accuracy tolerances. Individual component accuracy tolerances shall be as indicated by contract requirements, or by published manufacturer accuracy specifications, whenever contract accuracy tolerances are not indicated.

5. Each analog network shall be tested by applying simulated inputs to the first element(s). Simulated sensor inputs corresponding to 10 percent, 50 percent, and 90 percent of span shall be applied, and the resulting outputs read to verify compliance to network accuracy tolerance requirements. Continuously variable analog inputs shall be applied to verify the proper operation of discrete devices. Temporary settings shall be made on controllers, alarms, etc., during analog loop tests. All analog loop test data shall be recorded on test forms, which include calculated root-mean-square summation system accuracy tolerance requirements for each output.

6. When installation and loop tests have been successfully completed for all individual instruments and all separate analog control networks, a certified copy of all test forms signed by the Owner's representative as a witness, with test data entered, shall be submitted together with a clear and unequivocal statement that all instrumentation has been successfully calibrated, fully inspected, and fully tested.

C. System Pre-commissioning:

1. The CONTRACTOR shall responsible for demonstrating the operability of all systems provided under this specification. Pre-commissioning shall commence after acceptance of all wire, all calibrating and loop tests, and all inspections have been conducted. Pre-commissioning shall demonstrate proper operation of all systems with process equipment operating over full operating ranges under actual operating conditions.

2. The CONTRACTOR shall develop and submit to the ENGINEER for approval a Pre-Commissioning Plan which describes detailed test procedures, checklists, blank forms and data to be recorded, test equipment to be used and calculated tolerance limits.

3. System pre-commissioning activities shall include the use of water to establish service conditions that simulate, to the greatest extent possible, normal final control element operating conditions in terms of applied process loads, operating ranges and environmental conditions. Final control elements, control panels, and ancillary equipment shall be tested under start-up and steady-state operating conditions to verify that proper and stable control is achieved using motor control center and local field mounted control circuits. All hardwired and software control circuit interlocks and alarms shall be operational.

4. The control of final control elements and ancillary equipment shall be tested using both manual and automatic (where provided) control circuits. The stable steady-state operation of final control elements running under the control of field mounted automatic analog controllers or software based controllers shall be assured by adjusting the controllers, as required, to eliminate oscillatory final control element operation. The transient stability of final control elements operating under the control of field mounted, and software based automatic analog controllers shall be verified by applying control signal disturbances, monitoring the amplitude and decay rate of control parameter oscillations (if any) and making necessary controller adjustments, as required, to eliminate excessive oscillatory amplitudes and decay rates.

5. All electronic control stations incorporating proportional, integral or differential control circuits shall be optimally tuned, experimentally, by applying control signal disturbances and adjusting the gain, reset or rate setting(s) as required to achieve a proper response. Measured final

control element variable position/speed setpoint settings shall be compared to measured final control element position/speed values at 10 percent, 50 percent and 90 percent of span and the results checked against indicated accuracy tolerances. Accuracy tolerances are defined as the root-mean-square summation of individual component accuracy tolerances.

6. Individual component accuracy tolerances shall be as indicated in the Contract Documents or as specified by published manufacturer accuracy specifications whenever not indicated.

7. The CONTRACTOR shall submit an instrumentation and control system pre-commissioning completion report which shall state that all Contract requirements have been met and which shall include a listing of all instrumentation and all control system maintenance and repair activities conducted during the pre-commissioning testing. The ENGINEER must accept the instrumentation and control system pre-commissioning testing before the 14 day operational testing may begin. Final acceptance of the control system shall coincide with final acceptance of the WORK.

D. Operational Testing

1. 14-Day Operational Testing: The CONTRACTOR shall furnish his own personnel, electrical personnel, and any instrument manufacturer's representatives as required during the testing period to produce and maintain a fully operational system.

3.9 OPERATIONS AND MAINTENANCE MANUALS:

A. The CONTRACTOR shall furnish to the OWNER 6 complete sets of operation and maintenance manuals. The manuals shall include date, information drawings, etc., for the system, subsystem, and all components, and shall include names, addresses and telephone numbers of equipment suppliers, representatives and repair facilities.

B. This shall include a complete description of the recommended operating procedures, maintenance procedures, and spare/replacement parts list for equipment items with catalog data, diagrams, and drawings or cuts describing the equipment. Each set shall include full size assembly and wiring diagrams; drawings showing "as-built" conditions shall be furnished to the OWNER.

3.10 TRAINING

A. Instruction: The CONTRACTOR shall train the OWNER'S maintenance personnel in the maintenance, calibration and repair of all instruments provided under this contract as well as the PLC programming and operation.

B. The training shall be scheduled a minimum of 3 weeks in advance of the first session. The training shall be performed concurrent with the pre-commissioning.

C. The training shall be performed by qualified representatives of the licensed MCC SCADA systems integrator and the MCC and instrument manufacturers and shall be specific to each instrument model provided. Instructors shall have at least 2 years of training experience.

D. Each training class shall be a minimum of 4 hours in duration and shall cover Operational Theory, Maintenance, Trouble Shooting/Repair, and Calibration of the instrument.

E. Proposed training material, including resumes for the proposed instructors and a detailed outline of each lesson shall be submitted to the ENGINEER at least 30 days in advance of when the lesson is to be given. The ENGINEER shall review the submitted data for suitability and provide comments that shall be incorporated into the course.

F. Within 10 days after the completion of each lesson the CONTRACTOR shall present to the ENGINEER the following:

1. A list of all OWNER personnel that attended the lesson.

3.11 FINAL ACCEPTANCE TEST (FAT)

A. After start up and commissioning has been completed, the System shall undergo a 14-day Final acceptance test (FAT).

B. The FAT shall not commence until all training is complete and the operations and maintenance manuals approved as-noted

C. The System must run continuously for 14 consecutive days. During this period, all System functions shall be exercised by the Owner. Any System interruption and accompanying component, subsystem, or program failure shall be logged for cause of failure, as well as time of occurrence and duration of each failure.

D. A failure shall cause termination of the 14-day acceptance test. Continuation of the FAT shall be based on the following criteria:

1. A minor (No Equipment Shutdown) malfunction or error that is identified and corrected within 4 hours of the event. The FAT shall be stopped and restarted at the time of correction.

2. An equipment shutdown or failure that is non-essential to system operation shall stop the FAT until the cause is identified and corrected. Three shutdown events shall stop the FAT and it shall be restarted from the beginning.

3. A system shutdown event that initiates a plant, process or system shutdown. Shall terminate the FAT.

4. An operational error that requires operator action, which is not normal to the operation of the system to monitor and conduct operations, shall terminate the FAT.

E. When the cause of a failure has been corrected, a new 14-day acceptance test shall be started. Each time the CONTRACTOR'S technician is required to respond to a System malfunction, he must complete a report that shall include details concerning the nature of the complaint or malfunction and the resulting repair action required and taken.

END OF SECTION

SECTION 13330
FIELD INSTRUMENTATION

PART 1 – GENERAL

1.1 SCOPE OF WORK

A. Provide all devices, wiring, terminal blocks, accessories, and enclosures as specified herein and as shown on Contract Drawings for the instrumentation system. The Contract Documents are intended as an outline for the work and are descriptive of the type of hardware and software configuration to be provided. Any error or omission of detail shall not relieve the Contractor from the obligations there under to provide and install in correct detail any and all materials necessary for a complete operational instrumentation system, at no additional cost to the City.

B. The contract documents are not intended to cover every detail of materials, software, hardware, configuration, or construction. The Contractor shall furnish all tools, temporary utilities, materials, setup, parts, labor, and other incidentals necessary to fully complete the entire work, whether or not said details are particularly shown or specified, all at no additional cost to the City.

1.2 RELATED WORK

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK with respect to interfacing electrical and control system packaged under the mechanical and civil specification sections.

B. Installations of primary elements which require placement into or taps off of a process flow line are included under Division 15 Mechanical.

1.3 SUBMITTALS

A. Provide submittals and drawings as specified in Section 13300 Instrumentation and Control and Section 16010 Electrical.

1.4 OPERATING INSTRUCTIONS

A. Provide operating instructions as specified in Section 16010 - Electrical, OPERATING INSTRUCTIONS.

PART 2 – PRODUCTS

2.1 QUALITY

A. Quality includes that specified in Section 13300 Instrumentation and Control, and Section 16010 Electrical.

B. All equipment shall be designed and constructed so that in the event of a power interruption, the equipment specified hereunder shall resume normal operation without manual resetting or operator interaction when power is restored. All instrumentation shall be provided with non-volatile memory to retain all programming and configuration in the event of a power interruption.

C. Signal transmission from remote or field electric and electronic devices shall be 4-20 mA, sourced by a 24 VDC loop supply from the panel that is to receive the signal. Nonstandard transmission methods such as impulse duration, pulse rate, and voltage regulated will not be permitted except where specifically noted.

D. Outputs of equipment that are not of the standard signals as outlined, shall have the output immediately raised and/or converted to compatible standard signals for remote transmission.

2.2 PRESSURE GAUGE

A. Pressure gauges shall be installed on discharge connections to pumps and at each side of pressure reducing valves and where otherwise indicated.

B. Gauges shall have Type 316 stainless steel movement and stainless steel or phenolic case. Except as otherwise indicated, gauges shall have a 4-1/2-inch dial, ½-inch threaded connection, a Type 316 stainless steel snubbed adapter, and a shut-off valve. Gauges shall be calibrated to read with an accuracy of ± 1 percent to 150 percent of the indicated pressure. Gauges shall be vibration and shock resistant. Gauges on liquid service should have cases filled with a suitable liquid.

C. Gauges attached to systems containing chemical solutions, corrosive fluids, sludge, sewage, or other liquids containing solids, shall be equipped with diaphragm seals, or equal protective pressure or vacuum sensing devices, and comply with the following:

1. Seals shall be fabricated with Type 316 stainless steel, with stainless steel diaphragm for pressures over 15 psi, and elastomer diaphragm for pressures of 15 psi and below with Type 316 stainless steel nuts and bolts, fill connection and valved flush port size ¼-inch N.T.P., capable of disassembly without loss of filler fluid.

D. Combined pressure gauge and switch assemblies PI/PSHH shall be provided as a complete assembly by the System Integrator for installation by the contractor.

E. Pressure gauges shall be Wika, Ashcroft or equal.

F. Pressure gauges shall operate in the range of 0 – 150 psi.

2.3 FLOW METER (MAGMETER)

A. The flow meter shall consist of a flow tube flow element (FE) and an integral indicator/totalizer FQ/FIT with a 4 – 20 mA transmitter and pulse output, complete with all necessary interconnecting cables and conduits.

B. Flow tube shall be ANSI 150#.

C. Remote transmitter assembly shall be provided.

D. Indicator/Register shall provide an analog signal. Provide hood to protect register from direct sunlight. Register shall be provided with two displays a continuous flow display and totalizer.

E. The FQ/FIT shall provide both a 4-20 mA analog signal output proportional to the flow rate and pulsed output programmable in gallons. The flow rate indicator and totalizer shall be an integral part of the flowmeter assembly. The flowmeter shall be Sparling, FM 656 Tigermag EP, with remote transmitter, or approved equal.

F. Electrode Material shall be 316 Stainless Steel.

G. Provide grounding rings.

H. Liner Material shall be polyurethane.

I. Sensor shall be permanent submergence-proof.

J. Sensor Cable: The sensor cable shall be a multi-conductor, abrasive resistant, polyurethane jacketed cable flexible to -40°F. The sensor cable shall be permanently bonded to the sensor. Cable length shall be coordinated with the Contractor for connection to the remote transmitter.

K. Pressure/Temperature Limits: -40 to 266°F

L. The flow meter shall operate at pressures up to 300 psi.

M. Power Requirements: 120V, 60 Hz. Power consumption shall not exceed 20 Watts.

N. The meter shall have flanged connections conforming to ANSI B16.5, Class 150. Meter size shall be as shown on the Contract Drawings.

O. The meter accuracy shall be at least 0.5% of flow rate over a 33:1 turndown at all flow rates above 1 foot-per-second (fps). Accuracy shall be verified by calibration in a flow laboratory traceable to the U.S. National Institute of Standards and Technology.

P. The exterior of the flow meter shall be factory epoxy painted.

Q. The range of the flowmeter shall be a minimum of 0 – 6,000 GPM with a peak flow of 7-8 fps.

R. Flow meter shall be Sparling Tiger MagEP or equal.

PART 3 – EXECUTION

3.1 WORKMANSHIP

A. All instrumentation work in this contract shall conform to the codes and standards specified in Section 16020 – Electrical and Section 13300 Instrumentation and Control.

A. The Contractor shall employ personnel who are skilled and experienced in the installation and connection of all elements, equipment, devices, instruments, accessories, and assemblies. All installation labor shall be performed by qualified personnel who have had experience on similar projects. Provide first class workmanship for all installations.

B. Ensure that all equipment and materials fit properly in their installations.

C. Perform any required work to correct improper installations at no additional expense to the City.

D. The City reserves the right to halt any work that is found to be substandard or being installed by unqualified personnel.

E. Rejected equipment or equipment without approved submittals shall be immediately removed from the delivery or job site by the Contractor.

3.2 INSTALLATION

A. Contract Drawings are intended to show the basic functional requirements of the instrumentation system and do not relieve the Contractor from the responsibility to provide a complete and functioning system.

B. All wires shall be identified with machine printed labels. Plastic wire gutters shall be used for routing of wire bundles. Wiring shall be neat and laced with plastic tie wraps.

C. Install and supply all products necessary, at no additional cost to the City, to provide an operational system. This shall include the following:

1. Provide relays, signal converters, isolators, boosters, power conditioners, circuit cards, and other miscellaneous devices as required for the proper interface.

2. Provide analog loop isolators where required to eliminate "ground loops."

3. The instrumentation and accessory equipment shall be installed in accordance with the manufacturer's instructions and located as shown on the Drawings or as approved by the Engineer. When manufacturer's installation literature specifies a particular location or orientation in a process line due to measurement accuracy considerations, the installation shall be in conformance with the manufacturer's instructions.

4. Engineering scales and charts for all instruments shall be provided that match the range of instruments that monitor the process. All displays and scales shall read in engineering units.

D. Instrument installation methods.

1. Install instruments at the location shown on the Plans or approved by the City. Instruments shall be NEMA rated for the installed location.

2. Install level and plumb.

3. All instruments shall be provided with floor stands, stanchions or wall brackets as shown or required for operation.

4. Mounting hardware, stands, channels, and spacers shall be either stainless steel, or non metallic to match the NEMA rated location.

5. All screws and bolts shall be stainless steel.

E. Wiring and raceway installation methods.

1. Instrumentation wiring shall be carried in conduits provided in compliance with the Division 16. All analog circuits shall be run as twisted pairs or triads. In no case shall a circuit be made up using conductors from different pairs or triads. Triads shall be used wherever three wire circuits are required. Triads are not to be formed by using two pairs. Terminal blocks shall be provided at all instrument cable junctions and all wires shall be identified at such junctions. Instrumentation wiring shall be run without splices between instruments, terminal boxes, or panels.

2. The number of signal wires listed on the drawings is approximate only, and the Contractor shall determine the required number of signal pairs or triads to properly connect the system furnished, especially when substituting equipment.

F. Wiring, grounding, and shielding methods.

It is important to observe good grounding and shielding practices in the generally noisy environment in this application. The following practices shall be observed unless modified by manufacturer's standards:

1. Each electronic equipment chassis shall be grounded to power ground.

2. All analog signals shall be transferred over shielded twisted pair cables.

3. All communication signals shall be transferred over shielded cables.

4. All shields of analog inputs to the PLC shall be connected at the PLC unit only. They shall not contact ground at any other point including the transmitters.

5. All shields of analog outputs from the PLC shall be grounded only at the receiving device. They shall not contact ground at any other point including the PLC.

6. Status and alarm signals routed through noisy environment shall be transferred over shielded twisted pair cables.

7. Each shield which is not connected to ground shall be covered with a heat shrink insulating boot. Shields shall be connected together at each transition from one cable to another for a continuous effective shield circuit. All shields shall be connected on terminal blocks.

3.3 SUPPLIER SERVICES

A. The Contractor shall be responsible for each supplier of equipment to provide the following minimum services for each type of instrument supplied. The supplier shall use a qualified instrumentation field technician (sales representatives are not acceptable) to perform services listed herein.

1. Advise and instruct Contractor on application and installation requirements.

2. Check, calibrate, and place equipment in operation.

3. All programmable of field devices shall be programmed and tested prior to startup. Programming shall be adjusted or changed as directed by the City or Engineer, at no additional cost.

4. Coordinate with the City and setup all alarm, process, and operation setpoints.

5. Perform the acceptance tests.

6. Visit the job as often as required and spend as much time as necessary to ensure an operational instrumentation system.

7. Be readily available by telephone to answer all questions on supplied equipment.

8. Provide training as specified.

B. The Contractor shall insure each supplier of instrumentation assumes the responsibility for providing primary elements in a timely manner, for insertion into the process line, coordinating size and material type when applicable, overseeing the actual installation, calibration, and acceptance testing.

3.4 TRAINING

A. Each supplier shall provide a minimum of one (1) hour of training to instruct City personnel in the use, operation, calibration, programming, and maintenance on each different type of "field" instrument.

3.5 SPARE PARTS

A. Corrosion Inhibitors.

B. Provide additional spare parts as specified in Section 16010 - Electrical, SPARE PARTS.

3.6 WARRANTY

A. Provide warranty of 12 months after notice of completion.

B. Each time the Supplier's repair person responds to a system malfunction during the warranty period, he or she must contact the designated City maintenance supervisor for scheduling of the work, access to the jobsite, and permission to make repairs. Operation of facilities necessary to test equipment shall only be performed by or under the direction City staff. The City reserves the right at its sole discretion to deny operations requested by the Supplier.

3.7 FINAL ACCEPTANCE

A. Provide final acceptance as specified in Section 16010 - Electrical, FINAL ACCEPTANCE.

B. At the end of the project, following the completion of the field tests, and prior to final acceptance, the Supplier shall provide the following to the City:

1. Each "operation and maintenance" manual shall be modified or supplemented by the Supplier to reflect all field changes and as-built conditions.

END OF SECTION

SECTION 13500
PROGRAMMABLE LOGIC CONTROLLER (PLC) CONTROL SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Programmable logic controller (PLC) control system, including software, programming, startup and training.
   2. Connection and configuration of PLC into existing plant PLC Modbus + network.

1.2 REFERENCES

A. ANSI/IEEE C37.90.2	Trial-Use Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.
B. ANSI/IEEE C62.41	IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
C. ANSI/IEEE C62.45	IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits.
D. EIA TIA-232-E	Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange.
E. EIA 422-A	Electrical Characteristics of Balanced Voltage Digital Interface Circuits.
F. ISO 9001	Quality Systems-Model for Quality Assurance in Design, Development, Production, Installation and Servicing.
G. NEMA ICS 1	General Standards for Industrial Control and Systems.
H. NEMA ICS 4	Terminal Blocks for Industrial Use.
I. NEMA ICS 6	Enclosures for Industrial Controls and Systems.
J. NEMA LS1	Low Voltage Surge Protection Devices.
K. NEMA Publication No.250	Enclosures for Electrical Equipment (1000 V maximum).
L. UL 1283	Standard for Safety-Electromagnetic Interference Filters.
M. UL 1449	Standard for Transient Voltage Surge Suppressors.

1.3 SUBMITTALS

A. Product Data:
   1. Data sheets on each product to be used.
   2. Panel elevation and schematic drawings.
   3. Panel wiring diagrams.
   4. List of all recommended spares for maintenance purposes with each item separately priced.
   5. Annoted hard copies of PLC software programs.
      a. Submit program for logic in ladder diagram format as used for the specific PLC system. Annotate program listing to include the following:
         1) Written description of each rung's function.
         2) Reference to control loop number for each rung where applicable.
         3) Reference to instrumentation tag number of I/O devices for each rung where applicable.
      b. Provide written descriptions completely defining all function blocks used in program.
      c. Provide list of all addresses referenced in logic diagram with description of data associated with each address.
   6. Approved working Program used in PLC.

B. Quality Assurance/Control Submittals:
   1. Test Reports:
      a. Results of factory testing procedures.
   2. Certificates:
      a. Qualifications of installation supervisor.
      b. Qualifications of programmer(s).
      c. Upon satisfactory completion of startup, secure written statement from supplier that system is installed in accordance with requirements, is properly started up and is ready for operation by the Owner's personnel. Also certify that required operation and maintenance training has been fully satisfied.
      d. Programming software license.

C. Installation, Operation, and Maintenance Manuals:
   1. Include:
      a. PLC components.
      b. Surge protectors.
      c. Power supplies.
      d. UPS.
      e. Configuration and software manual.
      f. Final licensed version of software on CD or other Owner approved format including PLC and PLC programming software.
      g. Internal register addresses (for Owner SCADA configuration).
      h. As-built panel drawings.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturer is acceptable:
   1. PLC: Control Microsystems, SCADAPack 357, no substitutions.
   2. UPS:
      a. APC.
      b. UPS limited.
      c. Or approved equal.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. See Division 13 and Division 16 requirements for related work.

B. The PLC shall be installed in a freestanding, NEMA 3R control cabinet, along with all associated devices necessary for a complete and operable control system. Associated devices shall include plastic wire troughs, DIN rail mounted circuit breakers, power supplies, fuses, and auxiliary relays if required.

C. Control cabinet shall be sized to accommodate the PLC, flow transmitter, radio, UPS and other devices. Steel cabinet shall be vandal proof with fully hinged blank outer door, padlockable latch handle, painted light green (Owner to select color).

D. The PLC system shall accomplish the control requirements of the loop descriptions, Drawings, and Specifications.

E. PLC programming shall be documented and factory tested.

F. The PLC system shall operate in ambient conditions of 32 to 140 degrees F temperature and 5 to 95 percent relative humidity without the need for purging or air conditioning.

G. Environmental Controls:
   1. Furnish circulation fans in solid state control system enclosures.
   2. Over-temperature switches shall be utilized to provide special cooling if required to maintain operating temperatures within the manufacturer's specified range.
   3. Air conditioning applications shall include means of preventing moisture condensation.

H. All PLC control system components shall be capable of meeting or exceeding electromagnetic interference tests per ANSI/IEEE C37.90.2.

I. Incorporate the following minimum safety measures:
   1. Watchdog function to monitor:
      a. Internal processor clock failure.
      b. Processor memory failure.
      c. Processor ceases to execute logic program.
   2. Safety function wiring:
      a. Emergency shutdown switches shall not be wired into the controller.
   3. An emergency power disconnect shall be placed in the power circuit feeding the power supply as a means of removing power from the entire PLC system.

4. Safe wiring:
   a. Unless otherwise specified, activation of alarms and stopping of equipment shall result from the de-energization of control circuits, rather than the energization of control circuits.
   b. Low voltage control signal wires:
      1) Place in conduit segregated for that purpose only.
      2) Twisted shielded wire pair.
      3) Not located in the same conduit or bundle with power wiring.
5. Initial safety conditions:
   a. Utilize program module to dictate output states in a known and safe manner prior to running of control program.
   b. Utilize program each time PLC is re-initiated and the control program activated.
6. Monitoring of internal faults and display:
   a. Internal PLC system status and faults shall be monitored and displayed. Monitored items shall include:
      1) Memory ok/loss of memory.
      2) Processor ok/processor fault.
      3) Scan time overrun.
7. Control of programs:
   a. Protect access to PLC program loading with password protection
   b. Provide password information to Owner.
8. Design PLC system with high noise immunity to prevent occurrence of false logic signals resulting from switching transients, relay and circuit breaker noise or conducted and radiated radio frequency interference.
9. Incorporate noise suppression and inductive load suppression design into input, output, and logic modules.
   a. Provide surge suppressors directly across the coils of all inductive devices which are energized by PLC outputs. Install the surge suppressor at location of the inductive device.
10. Operator intervention:
    a. Logic system failure shall not preclude proper operator intervention.
    b. Safety shutdown of equipment or a system shall require manual operator intervention before the equipment or system operation may be reestablished.
    c. PLC shall not be password protected.

2.3 COMPONENTS

A. PLC System Board:
   1. PLC shall be as manufactured by Control Microsystems, Model P357-1A20-AB00, or as approved recommended model with current updates.
   2. PLC shall provide communications output to MDS radio, Model 9710, via serial port.
   3. Contractor shall wire all I/O from the field directly to the PLC, using plastic wire troughs and wiring supports to avoid any stress on PLC terminal.
   4. Memory:
      a. Battery-backed RAM.

b. EEPROM program back-up:
   1) Automatically download to RAM in the event RAM is corrupted.

5. Memory battery backup shall be capable of 60 days memory retention with fresh battery.
   a. Provide visual indication of battery status and alarm low battery voltage.
   b. Memory battery backup shall be capable of 14 days memory retention after the "Battery Low" indicating LED is on.
6. Plug-in card design to allow quick field replacement of faulty devices.
   a. Provide unit designed for field replacement and expansion of memory without requiring rewiring or use of special tools.
7. 20 percent minimum spare useable memory capacity after all required programming is in place and operating.
8. Capable of executing all control functions required by the Specifications and Drawings.
9. Built-in three-mode (proportional-integral-derivative) control capabilities.
   a. As directly selectable algorithms requiring no user knowledge of programming languages.
10. On line reconfigurable.
11. Lighted status indicators for "RUN" and "FAILURE."
12. Capable of manual or automatic control mode transfer from the operating console stations or from within the control strategy. Transfer shall be bumpless and balanceless.

B. Input/output (I/O) Modules.
1. Provide plug-in modular-type I/O racks with cables to connect to all other required PLC system components.
2. Provide I/O system with:
   a. I/O solid state boards with status lights indicating I/O status.
   b. Electric isolation between logic and field device.
   c. Capability of withstanding low energy common mode transient to 1000 V without failure.
   d. Incorporate noise suppression design.
   e. Capable of meeting or exceeding electrical noise tests, NEMA ICS1-109.60-109.66.
   f. Capable of being removed and inserted into the I/O rack under power, without affecting any other I/O modules in the rack.
   g. Install 20 percent spare I/O modules.
3. Input/output connection requirements:
   a. Make connections to I/O subsystem by terminating all field wiring on terminal blocks within the I/O enclosure.
   b. Prewire I/O modules to terminal blocks.
   c. Provide terminal blocks with continuous marking strip.
   d. Size terminals to accommodate all active data base points and spares.
   e. Provide terminals for individual termination of each signal shield.
   f. Field wiring shall not be disturbed when removing or replacing an I/O module.

4. Discrete I/O modules:
   a. Interface to ON/OFF devices.
   b. I/O status indicator on module front.
   c. Voltage rating to match circuit voltage.
   d. Output module current rating:
      1) Match maximum circuit current draw.
      2) Minimum 1.0 continuous A/point for 120 V AC applications.
   e. Isolated modules for applications where one module interfaces with devices utilizing different sources of power.
5. Discrete outputs shall be fused:
   a. Provide one fuse per common or per isolated output.
   b. Provide blown fuse indication.
   c. External fusing shall be provided if output module does not possess internal fusing.
   d. Fuses provided external to output model shall:
      1) Be in accordance with module manufacturer's specifications.
      2) Be installed at terminal block.
6. Analog I/O modules:
   a. Input modules to accept signals indicated on Drawings or Specifications.
   b. Minimum 12 bit resolution.
   c. I/O chassis supplied power for powering connected field devices.
   d. Differential inputs and outputs.
   e. User configurable for desired fault-response state.
   f. Provide output signals as indicated on Drawings and Specifications.
   g. Individual D/A converter for each output module.
   h. Individual A/D converter for each input module.
   i. Analog input modules to be 140 ACI03000 or AS-BADU-205 and analog output modules to be 140 AC00200 or AS-BDAU-204.

C. Power Supply Units:
1. Provide regulated power units:
   a. Designed to operate with PLC system and shall provide power to:
      1) All components of PLC system.
      2) All two-wire field instruments.
      3) Other devices as indicated on Drawings or Specifications.
   b. Capable of supplying PLC system when all of the specified spare capacity is utilized.
   c. Each power supply shall be sized such that it will carry no more than 75 percent of capacity under normal loads.
2. Electrical service to PLC system is 105 to 125 V, 60 HZ, +1 percent, 1 PH power.
3. Separate AC circuit breakers shall be provided for each power supply.
4. Capable of meeting or exceeding electrical noise tests, NEMA ICS1-109.60-109.66.
5. Power distribution:
   a. Immune to transients and surges resultant from noisy environment.

b. Shall provide constant voltage level DC distribution to all devices.

6. Provide uninterruptible power supply (UPS) to sustain full power to UPS powered loads listed below for a minimum of 15 minutes following loss of primary power and to ensure that the transient power surges and dips do not affect the operation of the PLC system.
   a. UPS powered loads:
      1) All PLC components.
      2) Magnetic flow meter.
      3) All power supplies furnished with the PLC and associated loads.
   b. Input:
      1) 120 V AC +/-10 percent.
      2) 60 HZ.
      3) Line fuse protection.
   c. Output:
      1) 120 V AC ±5 percent.
      2) 60 HZ.
      3) Short circuit protected.
      4) Instantaneous transfer time.
   d. ANSI/IEEE C62.41 Class A voltage surges of 6000 V attenuated to less than 50 V on the output.
   e. Battery: Maintenance free lead acid.
      1) Install battery in ventilated space in accordance with NEC, Article 480.

D. Power Supply Surge Protection (Hard wired type):
   1. Acceptable manufacturer:
      a. Innovative Technology, Model HS-P-SP.
      b. Tripp Lite.
   2. Utilize for 120 V AC power supplied to PLC.
   3. Design and fabrication:
      a. Components, except for enclosure, shall meet all requirements related to construction, performance, manufacturing/production-line testing, ratings, and markings as stated in UL 1449 for a transient voltage surge suppressor rated as required by these Contract Documents.
      b. Maximum continuous line voltage: 130 V AC.
      c. Shall be rated for maximum continuous line current of protected equipment.
      d. Wired in series with the power supply.
      e. Device protection modes:
         1) Line to neutral (L-N).
         2) Line to ground (L-G).
         3) Neutral to ground (N-G).
      f. Peak surge current, 8x20 microsecond waveform:
         1) 65,000 amps total.
         2) 45,500 amps phase.

g. Maximum values of actual let-through voltage for installed surge protection devices when exposed to a B 3/C1 impulse wave (per ANSI/IEEE C62.41) of 6,000 volts and 3,000 amps shall be in accordance with the following table:

B3/C1 IMPULSE WAVE PER NOMINAL CONTINUOUS VOLTAGE, RMS	LET-THROUGH VOLTAGE, RMS
120 L-N	210
120 L-G	230
120 N-G	380

h. Diagnostics:
   1) Local indication that protective circuitry is functioning properly.
   2) Contacts for remote annunciation of malfunction.

i. Only firms that have been regularly engaged in the development, design, testing, listing and manufacturing of transient voltage surge suppressors for a period of ten years or more of the types and ratings required and whose products have been in satisfactory use in similar service are acceptable. Time spend as non-manufacturing private label re-seller shall be excluded. Upon request, suppliers or manufacturers shall provide a list of not less than three customer references showing satisfactory operation.

j. Only manufacturers with ISO 9001 certification are acceptable.

E. Data Line Surge Protection:
   1. Acceptable manufacturer:
      a. Innovative Technology, Model D2S, D4S, or D6S.
      b. Only manufacturers with ISO 9001 certification are acceptable.
   2. Install surge suppressor at PLC terminations for discrete I/O wiring applications where signal line extends outside of building.
   3. Install surge suppressor at both ends of data lines where data line extends outside of building.
   4. Series wired.
   5. All mode protection (normal and common).
   6. Less than 1 nanosecond response time.
   7. Maximum let through voltage when exposed to a B3/C1 impulse wave (per ANSI/IEEE C62.41) of 6,000 volts and 3,000 amps:

Max Continuous Voltage	Max Let-Through Voltage
7.5 L-L	20
7.5 L-G	30
7.5 SHD-G	170
15 L-L	30

15 L-G	40
15 SHD-G	170
36 L-L	70
36 L-G	70
36 SHD-G	170

F. PLC System Software and Programming:
   1. Provide programming to accomplish all control and monitoring requirements of the Contract Documents.
   2. Provide two copies of control logic program on CD and hard copy.
   3. Use CONCEPT software.
   4. Full documentation capability.
      a. The PLC programming software shall be the latest release of Modbus RTU and DNP3. All PLC programming shall use Ladder Diagram (LD) format. Submit data identifying the programming software product name and version to be used on the project for approval.
      b. All PLC programming shall be clearly documented, including but not limited to, inputs, outputs, registers, instructions, rungs, branches, subroutines, sections, objectives, unusual procedures, etc. Documentation shall be provided via the programming software visually during the programming mode (online and offline), and documentation shall be provided separately using "Adobe pdf" format on a CDROM and a printed document both of which shall be provided in the form of a submittal. Any programming documentation deficiencies shall be remedied by Contractor at no additional cost.
      c. The Contractor shall provide an original copy "As-built" backup of all PLC programming, PLC related configuration and programming, and related documentation to Sonoma County in the form of two (2) sets of CDROMS and printed documents (one set to be left at the project site, and the other set to be provided to Sonoma County's IT Department).
      d. The PLC programming software shall be provided by the Contractor and registered in the name of Sonoma County Water Agency, and verification of registration shall be provided in a submittal for approval before substantial completion. All programmed and/or configured software related to this project shall become the property of Sonoma County Water Agency and shall be labeled as such with full-rights thereto. No software/document related to this project shall be labeled as proprietary or copyright protected or similar declaration. Provide Owner software registration information
   5. On/off line programming.
   6. Offline simulation prior to download.
   7. Two step commands requiring operator verification prior to deletion of any programming.
   8. Provide register data to Owner for Owner configuration of remote SCADA.

2.4 BUTTERFLY VALVE CONTROL

A. In addition to providing remote monitoring of water flow through the pipeline, the RTU/PLC shall provide remote control of the 18-inch butterfly valve. The butterfly valve shall be controlled by the PLC for full OPEN/CLOSE control. Refer to Section 15112 for butterfly valve and 15185 for actuator requirements.

B. The PLC shall monitor open/close valve status contacts, and a 4-20mA signal from the valve indicating valve position.

C. The PLC shall provide OPEN and CLOSE output signals to the valve actuator to initiate opening and closing.

D. PLC shall provide correct voltage, timers, and any logic needed for valve control based on valve actuator controls being provided.

E. The PLC shall allow the actuator to be disengaged from PLC control so that it can be manually operated with the wheel operator.

2.5 RADIO, ANTENNA, AND ACCESSORIES

A. Contractor shall provide a GE MDS_9710 radio (or equivalent SD09 with emulation mode), interconnection signal cabling, 30-foot galvanized steel antenna tower, Yagi TY-900 antenna, and all associated hardware and connectors for a complete radio communication system for the RTU. The radio system shall operate at 900 MHz.

B. The radio antenna shall be directed to Sonoma Mountain and shall communicate with the existing SVCSD SCADA radio system.

C. The radio and antenna system shall be installed as required by site conditions and manufacturer recommendations. The antenna mast shall be mounted in a concrete, steel reinforced pad. Complete antenna and mounting system shall be designed by Contractor, with structural PE stamp, for seismic and wind conditions at the site.

D. Provide all accessories required to furnish a complete PLC control system to accomplish the requirements of the Drawings and Specifications.

2.6 SOURCE QUALITY CONTROL

A. Provide a performance test after factory completion and prior to shipment.
   1. Conduct a test where the system is operated continuously and checked for correct operation including loop controls, displays, printing, keyboard functions, alarm responses, and on/off sequencing control.
   2. Conduct testing with dummy I/Os to verify each control loop operation.
   3. Allow for Owner to witness testing program. Provide minimum of 15 days notice prior to testing.
   4. Do not ship prior to successful completion of this testing program.

2.7 MAINTENANCE MATERIALS

A. Furnish OWNER with the following extra materials:
   1. One spare fuse of each type used.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install PLC control system in accordance with manufacturer's written instructions.

B. Install in control panel completely prewired to flow meter transmitter, radio, and power devices. The UPS may be field mounted.

3.2 FIELD QUALITY CONTROL

A. Employ and pay for services of equipment manufacturer's field service representative(s) to:
   1. Inspect equipment covered by these Specifications.
   2. Supervise adjustments and installation checks.
   3. Maintain and submit an accurate daily or weekly log of all commissioning functions.
      a. All commissioning functions may be witnessed by Owner.
      b. All reports shall be cosigned by Contractor and Owner if witnessed.
   4. Conduct startup of equipment and perform operational checks.
   5. Provide Owner with a written statement that manufacturer's equipment has been installed properly, started up, and is ready for operation by Owner's personnel.

3.3 DEMONSTRATION

A. On-Site Training:
   1. Provide employee of the manufacturer or certified representative to provide 2 Days of operating and maintenance training at the Site after the system has successfully undergone all field testing and acceptance procedures.
      a. As a minimum, training shall cover:
         1) Hardware overview.
         2) Software overview.
         3) Program overview.
         4) Maintenance.
         5) Trouble shooting.
         6) Operation, including changing set points, and passwords.

3.4 OPERATION

A. The Napa Marsh Pipeline shall not be placed in service or operated until the following conditions are met.
   1. The Agency's inspector shall be provided with written notice 72 hours prior to the equipment or system startup.
   2. The Contractor shall provide PLC register addressing code to the Agency as the Contractor develops and establishes PLC functionality. The contractor shall permit the Agency to communicate with any PLC during the development or activation of the project.
   3. The contractor shall verify that the analog signals for the physical parameters shall be calibrated to the accuracy specified.

B. The Contractor shall be responsible for providing and installing signal isolation devices as required or as specified.

C. The contractor shall be responsible for maintaining the analog signal and signal accuracy for the duration of contract completion and during the warranty period as specified in Divisions 0 and 1 of the specifications.

3.5 LOOP CHECK

A. The Contractor shall complete the loop check form for the operation of magnetic flowmeter.

B. Use attached loop check form.

<SITE NAME> <PROJECT NAME> INPUT LOOP CHECKS

Scale to 0.00% Accuracy		Measurement			Mfg Acceptable Range	PLC Address	Equip. Tag	Initials	Time & Date	Notes & Comments
		Test	Actual	Percent Error of Reading						
0% Span	Applied Process Variable Value	0.00 PSI					PIT-004			
	Loop (mA)	4								
	Panel Display	N/A	N/A	N/A						
	PLC (SCADA) Display	0.00 PSI								
10% Span	Applied Process Variable Value									
	Loop (mA)									
	Panel Display									
	PLC (SCADA) Display									
25% Span	Applied Process Variable Value									
	Loop (mA)									
	Panel Display									
	PLC (SCADA) Display									
50% Span	Applied Process Variable Value									
	Loop (mA)									
	Panel Display									
	PLC (SCADA) Display									
75% Span	Applied Process Variable Value									
	Loop (mA)									
	Panel Display									
	PLC (SCADA) Display									
90% Span	Applied Process Variable Value									
	Loop (mA)									
	Panel Display									
	PLC (SCADA) Display									
100% Span	Applied Process Variable Value									
	Loop (mA)									
	Panel Display									
	PLC (SCADA) Display									

CALIBRATION EQUIPMENT USED: _____

_____

_____

TEST EQUIPMENT LAST DATE CALIBRATED: _____

END OF SECTION

DIVISION 15

MECHANICAL

SECTION 15005

FUSIBLE PVC PRESSURE PIPE

PART 1 GENERAL

1.01 REFERENCES

A. Commercial Standards

AWWA C900	Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. through 12 in. (100mm Through 300mm), for Water Distribution
AWWA C905	Standard for Polyvinyl Chloride (PVC Pressure Pipe and Fabricated Fittings, 14 in. through 48 in. (350mm Through 1200mm), for Water Distribution and Transmission
AWWA M23	AWWA Manual of Supply Practices PVC Pipe- Design and Installation, Second Edition
ASTM D1784	Rigid Polyvinyl Chloride (PVC) Compounds and Chlorinated Polyvinyl Chloride (CPVC) Compounds
ASTM D1785	Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2152	Test Method for Degree of Fusion of Extruded Poly vinyl Chloride (PVC) Pipe and Molded Fittings by Acetone Immersion
ASTM D2241	Polyvinyl Chloride (PVC) Plastic Pipe (SDR-PR)
ASTM D3034	Standard Specification for Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings
ASTM F1057	Standard Practice for Estimating the Quality of Extruded Polyvinyl Chloride (PVC) Pipe by the Heat Reversion Technique
NSF-14	Plastics Piping System Components and Related Materials
NSF-61	Drinking Water System Components--Health Effects
PPI TR-3	PVC Range Composition Listing of Qualified Ingredients

1.02 SUBMITTALS

A. **Shop Drawings:** Drawings of pipe, fittings, and appurtenances. Proposed pipeline grade and alignmentchanges.

B. Calculations showing compliance with this Section. Manufacturer's literature on the metallic locating tape. **Methods Statement:** Provide a thorough description of the fusing method including equipment, schedule, materials; cutting, joining, debris, containment, cleanup, etc. Installation procedures including maximum bending radius and pulling tension.

C. **Certifications:** A certified affidavit of compliance for all pipe and other products or materials furnished under this Section.

1. Hydrostatic proof test reports.
2. Sustained pressure test reports.
3. Burst strength test reports.

D. **Qualifications:** Provide documentation showing that the PVC pipe fusing technician is qualified and experienced..

E. The CONTRACTOR shall be responsible for performing and paying for sampling and testing as necessary for the certifications.

F. Post –Construction Submittal

1. The CONTRACTOR shall provide the following information after the pipe is installed:
   - Approved data logger device reports
   - Fusion joint documentation containing the following information:
     - Pipe diameter and thickness
     - Machine diameter
     - Fusion technician identification
     - Job identification
     - Fusion joint number
     - Fusion, heating, and drag pressure settings
     - Heat plate temperature
     - Time stamp
     - Heating and cool down time of fusion
     - Ambient temperature

1.03 QUALITY ASSURANCE

A. **Inspection:** Pipe shall be subject to inspection at the place of manufacture. Notify the Owner in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.

B. During the manufacture of the pipe, the Owner shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications.

C. **Tests:** Except as modified herein, all materials used in the manufacture of the pipe shall be tested in accordance with this Section and the referenced standards, as applicable.

D. The CONTRACTOR shall perform said material tests. The Owner shall have the right to witness testing.

E. In addition to those tests specifically required, the Owner may request additional samples of any material for testing by the Owner. The additional samples shall be furnished as part of the WORK.

PART 2 PRODUCTS

2.01 GENERAL

A. PVC pressure pipe shall conform to the applicable requirements of AWWA C900 and/or C905 and the additional requirements herein.

B. Color: Purple for recycled water.

2.02 PIPE

A. The pipe shall be of the diameter and lengths shown in the drawings and shall be furnished complete with specials and fittings as required in the Contract Documents.

B. The minimum pressure class shall be 235 psi.

C. **Additives and Fillers:** Unless otherwise provided in alternate qualification procedures of PPI-TR3, compounds which have a Hydrostatic Design Basis (HDB) of 4000 psi at 73.4 degrees F for water shall not contain additives and fillers that exceed the recommended values in Table 1, Part Y of PPI-TR3 (e.g., allowable content range for calcium carbonate is 0.0-5.0 parts per hundred parts of resin). If requested by the Owner, the additive and filler content shall be determined by using the pyrolysis method per ASTM D 2584.

D. **Joints:** Joints for buried PVC pipe shall be fused. No restrained joint PVC pipe will be allowed.

E. **Joint Deflection:** Fused joints may be combined to provide the grade changes shown in the drawings.

2.03 FITTINGS

A. Ductile-iron fittings for PVC pipe shall conform to either AWWA C110 (standard-style) or AWWA C153 (compact-style) except as herein modified. The pipe shall be of the diameter and class indicated, shall be provided complete with rubber gaskets, specials, and fittings as required under the Contract Documents.

B. Ductile-iron fittings shall be either:

1. Cement mortar lined in accordance with AWWA C104 and asphaltic coated in accordance with AWWA C153, or

2. Fusion-bonded epoxy lined and coated in accordance with AWWA C116 and Section F.10.4.

3. Every precaution shall be taken to prevent damage to the lining. If lining is damaged or found defective at the Site, the damaged or unsatisfactory portions shall be replaced with lining conforming to these Specifications.

4. Cement: Cement for mortar lining shall conform to the requirements of AWWA C104; provided, that cement for mortar lining shall be Type II. The

minimum lining thickness for nominal pipe diameter 3-12 in. shall be 1/16 in. Shop-applied cement mortar lining shall be given a seal coat of asphaltic material in conformance with AWWA C104.

5. The exterior coating shall be an asphaltic coating approximately 1-mil thick

C. Ductile-iron fittings with push-on-joint ends shall be rated for 350 psi working pressure.

D. Ductile-iron fittings with flange-joint ends shall be rated for 250 psi working pressure, minimum.

E. Joints: Ductile iron fittings shall be furnished with mechanical joints conforming to AWWA C111, flanged joints conforming to AWWA C115, or restrained joints as required.

1. Restrained Joints: All buried joints shall be restrained.

2. Flanged Joints: All exposed joints shall be flanged.

F. Cast markings on ductile-iron fittings shall include the following:

1. AWWA Designation Number (e.g., for compact fittings, ANSI/AWWA C153/A21.53)

2. Pressure rating

3. Nominal diameters of openings

4. Manufacturer's identification

5. Country where cast

6. The letters "DI" or "Ductile"

7. Number of degrees or fraction of the circle on all bends

G. Joint restraints for DI mechanical joints with PVC pipe shall meet or exceed the requirements of ASTM F1674. The gland shall consist of ductile iron conforming to ASTM A536 and shall conform to AWWA C111. Restraint shall be provided by individual bolt-tightened wedges which grip the spigot end of the adjacent pipe. Wedge-tightening bolts shall be factory provided with heads which break away when proper torque is reached. The spacing and number of bolt tightened wedges shall be designed by the manufacturer specifically for type of pipe they will grip. The DI gland shall be protected against corrosion with a high quality factory applied coating.

1. Nuts and bolts shall be stainless steel.

2. Megalug Series 1100 or 1100SD as manufactured by EBAA Iron, Inc. or approved equal.

H. Bolted sleeve couplings (flex couplings) shall conform to AWWA C219 and these specifications. Flex couplings shall consist of a stainless steel sleeve conforming to the material requirements of AWWA C200 or C220, respectively. The sealing

mechanism at each end of the sleeve shall consist of a rubber gasket certified by an ANSI accredited organization to be in compliance with NSF/ANSI 61 and compressed by a stainless steel compression ring. The Compression ring shall be tensioned by a single nut and bolt which acts perpendicular to the pipe centerline. Sleeves larger than 12 inches may use two nuts and bolts to provide tension. All fasteners and washers shall consist of stainless steel. Flex couplings shall provide for a minimum of 8 degrees of pipe deflection. All non-stainless steel components of flex couplings shall be protected from corrosion by a fusion-bonded epoxy coating conforming to AWWA C213, or another quality factory-applied coating approved by the Engineer.

1. Flex couplings shall have a working pressure of not less than 200 psi.

2. Hymax Couplings as manufactured by Total Piping Solutions, Inc. or approved equal.

I. DI fittings shall be protected against corrosion in accordance with Section 13110 and the project drawings.

2.04 PIPE MARKING

A. The pipe shall be marked as follows:

- Nominal pipe size
- PVC
- Dimension Ratio, Standard Dimension Ratio or Schedule
- AWWA pressure class
- AWWA standard designation number
- Extrusion production, record code
- Trademark or trade name
- Cell Classification 12454 and/or PVC material code 1120 may also be included

PART 3 EXECUTION

3.01 GENERAL

A. Laying, jointing, testing for defects and for leakage shall be performed in the presence of the Owner, and shall be subject to approval before acceptance. Material having defects will be rejected and the CONTRACTOR shall promptly remove such defective materials from the Site.

B. Installation shall conform to AWWA M23, instructions furnished by the pipe manufacturer, and to the supplementary requirements or modifications herein.

3.02 HANDLING AND STORAGE

A. **Handling:** Pipe, fittings, and accessories shall be carefully inspected before and after installation and those found defective shall be rejected. Pipe and fittings shall be free from fins and burrs. Before being placed in position, pipe, fittings,

and accessories shall be cleaned, and shall be maintained in a clean condition. Proper facilities shall be provided for lowering sections of pipe into trenches. Under no circumstances shall pipe, fittings, or any other pipe-related material be dropped or dumped into trenches.

B. **Storage:** Pipe should be stored, if possible, at the Site in unit packages provided by the manufacturer. Caution shall be exercised to avoid compression damage or deformation to bell ends of the pipe. Pipe shall be stored in such a way as to prevent sagging or bending and shall be protected from exposure to direct sunlight by covering with an opaque material while permitting adequate air circulation above and around the pipe. Store gaskets in a cool, dark place out of the direct rays of the sun, preferably in original cartons.

3.03 TRENCHING AND BACKFILL

A. Trench excavation and backfill shall conform to the requirements of Section 02320 Trenching, Backfilling, and Compacting for Utilities.

3.04 FUSION PROCESS

A. Fusible PVC pipe will be handled in a safe and non-destructive manner before, during, and after the fusion process and in accordance with this specification and pipe manufacturer's guidelines.

B. Fusible PVC pipe will be fused by qualified fusion technicians holding current qualification credentials for the pipe size being fused, as documented by the pipe manufacturer.

C. The pipe manufacturer's procedures shall be followed at all times during fusion operations.

D. Each fusion joint shall be recorded and logged by an approved electronic monitoring device (data logger) connected to the fusion machine, which utilizes a current version of the pipe manufacturer's recommended and compatible software.

E. Only appropriately sized and outfitted fusion machines that have been approved by the pipe manufacturer shall be used for the fusion process. Fusion machines must incorporate the following elements:

1. Heat Plate - Heat plates shall be in good condition with no deep gouges or scratches. Plates shall be clean and free of any debris or contamination. Heater controls shall function properly; cord and plug shall be in good condition. The appropriately sized heat plate shall be capable of maintaining a uniform and consistent heat profile and temperature for the size of pipe being fused, per the pipe manufacturer's guidelines.

2. Carriage – Carriage shall travel smoothly with no binding at less than 50 psi. Jaws shall be in good condition with proper inserts for the pipe size being fused. Insert pins shall be installed with no interference to carriage travel.

3. General Machine - Overview of machine body shall yield no obvious defects, missing parts, or potential safety issues during fusion.

4. Data Logging Device – An approved datalogging device with the current version of the pipe manufacturer's recommended and compatible software shall be used. Datalogging device operations and maintenance manual shall be with the unit at all times. If fusing for extended periods of time, an independent 110V power source shall be available to extend battery life.

F. Other equipment specifically required for the fusion process shall include the following:

1. Pipe rollers shall be used for support of pipe to either side of the machine
2. A weather protection canopy that allows full machine motion of the heat plate, fusion assembly and carriage shall be provided for fusion in inclement, extreme temperatures, and /or windy weather, per the pipe manufacturer's recommendations.
3. An infrared (IR) pyrometer for checking pipe and heat plate temperatures.
4. Fusion machine operations and maintenance manual shall be kept with the fusion machine at all times.
5. Facing blades specifically designed for cutting fusible polyvinylchloride pipe shall be used.

G. Joint Recording: Each fusion joint shall be recorded and logged by an electronic monitoring device (data logger) connected to the fusion machine. The fusion data logging and joint report shall be generated by software developed specifically for the butt-fusion of fusible polyvinyl chloride pipe. The software shall register and/or record the parameters required by the pipe manufacturer and these specifications. Data not logged by the data logger shall be logged manually and be included in the Fusion Technician's joint report.

3.05 INSTALLATION

A. Pipe shall be graded in straight lines, taking care to avoid the formation of any dips or low points. Pipe shall not be laid when the conditions of trench or weather are unsuitable. At the end of each day's work, open ends of pipe shall be closed temporarily with wood blocks or bulkheads.

B. Pipe shall be supported at its proper elevation and grade, care being taken to secure firm and uniform support. Wood support blocking will not be permitted. The full length of each section of pipe and fittings shall rest solidly on the pipe bed, with recessed excavation to accommodate joints and couplings. Anchors and supports shall be provided where indicated and where necessary for fastening work into place. Fittings shall be independently supported.

C. Short lengths of pipe shall be used in and out of each rigid joint or rigid structure. Piping that does not allow sufficient space for proper installation of jointing material shall be replaced by one of proper dimensions.

D. Joints shall be installed according to manufacturer's recommendations. Trenches shall be kept free of water until joints have been properly made. The maximum

combined deflection at any coupling shall be in accordance with the manufacturer's recommendations.

E. The pipe shall be cut and fused with specialty equipment as directed by the manufacturer. No hand cuts will be allowed.

F. The pipe will be installed in a manner so as not to exceed the recommended bending radius guidelines.

G. Where the pipe is installed by pulling in tension, the recommended maximum safe pulling force, established by the pipe manufacturer, shall not be exceeded.

3.06 TRACER WIRE

A. See Section 15051 Basic Piping Materials and Methods.

3.07 FIELD TESTING AND CLEANING

A. See Section 15051 Basic Piping Materials and Methods.

END OF SECTION

SECTION 15051
BASIC PIPING MATERIALS AND METHODS

PART 1 GENERAL

1.01

A. SUMMARY

1. Related Sections:

a) Section 02140 Dewatering

b) Section 02320 Trenching, Backfilling, and Compacting for Utilities

B. REFERENCES

ANSI/ASME B1.20.1	General Purpose Pipe Threads
ANSI/ASME B18.2.1	Square and Hex Bolts and Screws
ASTM A307-94	Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
ASTM A563-94	Standard Specification for Carbon and Alloy Steel Nuts
AWWA M11	Steel Pipe Design and Installation Manual
AWWA C105	Polyethylene Encasement for Potable Iron Pipe Systems
AWWA C207	Steel Pipe Flanges for Waterworks Service, 4-144 Inches
NSF/ANSI 61	Drinking Water System Components - Health Effects

C. SUBMITTALS

1. Product Data:

a) Piping systems not specified elsewhere in the Contract Documents:

(1) Material lists

(2) Protective coatings

b) Pipe supports

c) Polyethylene film

d) Tracer wire

e) Trench warning tape

f) Non-hardening elastomeric material for filling annular spaces around pipe in concrete structures

2. Shop Drawings:
   a) Piping systems not specified elsewhere in the Contract Documents:
      (1) Include all dimensions, details, and materials for pipe joints, fittings, fitting specials, spools, end connections, valves, and appurtenances.
      (2) Indicate protective coatings.
   b) Piping supports:
      (1) Locate each support and hanger
      (2) Identify the support by catalog number or shop drawing detail number
      (3) Show anchor locations and identify them by shop drawing detail number.
3. Pipe layout drawings showing entire piping system with overall dimensions
4. Quality Assurance/Control Submittals:
   a) Work Plans:
      (1) Pipe cleaning and flushing including:
         (a) Cleaning and flushing method
         (b) Schedule
         (c) Identification of water source
         (d) Method of protecting existing potable water supply from contamination
         (e) Method for filling and draining pipeline, including method for controlling surge, water hammer, and vacuum during filling and draining
         (f) Method for disposal of water and complying with permitted and specified water quality requirements
      (2) Hydrostatic testing including:
         (a) Hydrostatic testing method
         (b) Schedule
         (c) Identification of water source
         (d) Method of protecting existing potable water supply from contamination
         (e) Method for filling and draining pipeline, including method for controlling surge, water hammer, and vacuum during filling and draining

(f) Method for removing air from pipeline

(g) Method for disposal of water and complying with permitted and specified water quality requirements

b) Design Data:

(1) Design calculations for pipe strength

(2) Manufacturer’s quality control procedures

c) Test Reports:

(1) Piping systems

d) Manufacturer's installation instructions:

(1) Piping systems

D. QUALITY ASSURANCE

1. General:

a) Fittings and couplings: same manufacturer

b) Like items of materials: same manufacturer

2. Tests:

a) Except where otherwise specified, all materials used in the manufacture of the pipe: tested in accordance with the applicable Specifications and Reference Standards.

E. DELIVERY, STORAGE, AND HANDLING

1. Storage and Protection:

a) Store all materials in the original manufacturer's packaging.

b) Box loose items with no original packaging to protect the products from scratches, abrasion, or breakage.

c) Protect all products from excessive heat and from moisture during storage and handling.

d) Store all plastic materials out of direct sunlight.

e) Store pipe and fittings on suitable supports to prevent damage from bending and rolling, and contamination from dirt.

f) Cap or seal ends of pipes during storage.

g) Protect all machined surfaces exposed during shipment and storage from weather and dirt by bolting on plywood covers or covering with membrane covers.

h) Protect all exposed gaskets from weather and dirt with membrane covers.

i) Store loose gaskets in boxes.

2. Handling:

a) Lower each section of pipe into the trench, utilizing a sling or other device, in a manner that shall prevent injury to the pipe, coating, lining, or joints.

b) In placing pipe in the trench, hold pipe by the lowering device at the balancing point of the section.

c) Support pipe while fitting into adjacent section. Dragging is prohibited.

d) Supporting the pipe on blocks, or blocking of any nature, either temporary or otherwise, will not be allowed.

F. PIPE LINING AND COATING

1. Pipe lining and coatings: As indicated.

PART 2 PRODUCTS

2.01

A. GENERAL

1. All pipes, fittings, and appurtenances: in accordance with the requirements of the applicable Sections of Division 15, Mechanical, and as indicated.

2. Pressure rating: Design all piping systems for a minimum working pressure of 250 psi, unless otherwise indicated.

3. Unless otherwise indicated, all piping material:

a) Non-embedded pipe, 4 inch and smaller: Schedule 40 galvanized steel pipe.

b) Non-embedded pipe, over 4 inches: Schedule 40 shop-primed steel pipe.

c) Embedded pipe in concrete: Schedule 80 galvanized steel pipe.

d) Embedded pipe in earth: Schedule 80 PVC pipe.

4. All pipe, pipe lining materials, and appurtenant components in contact with potable water: NSF/ANSI 61 approved.

5. Provide such parts and pieces as may be necessary to provide a complete and operable system.

6. Pressure pipe systems: Provide restrained joints at all bends, tees, wyes, ends, changes in pipe size, and other locations subject to thrust movement.

7. Unless otherwise indicated, all steel pipe joints:

a) 4-inch and larger: flanged.

b) Less than 4-inches: threaded.

B. FLANGE COUPLING ADAPTERS

1. Manufacturers:

   a) Dresser, Style 128.

   b) Smith-Blair, Model 913

   c) Or Approved Equal

2. Construction:

   a) Fabricate from high strength steel.

   b) Meet AWWA C207 and all applicable ANSI standards.

   c) Provide compression ends with wedge gasket for efficient sealing.

   d) Gasket material: suitable for potable water.

   e) All bolts, nuts, and washers: Type 316 stainless steel.

   f) Provide thrust harness on all flanged coupling adaptors, conforming to AWWA Manual M11.

   g) Line and coat flanged coupling adaptor with NSF/ANSI 61 approved epoxy coating material.

3. Pipe Preparation:

   a) Prepare pipe ends in accordance with manufacturer's recommendations.

   b) Verify the outside diameter and pipe type prior to ordering adapters.

   c) Line and coat steel pipe over 4-inch diameter with NSF/ANSI 61 approved epoxy coating material.

   d) Cement mortar coated pipe:

      (1) Leave back cement mortar coatings for coupling and thrust harness.

      (2) Coated with NSF/ANSI 61 approved epoxy coating material from end of pipe to cement mortar coating intersection.

      (3) Polyethylene encasement per AWWA C105 over completed coupling and harness installation, extending over full length of non-mortar coated pipe, and securely fastened at each end.

C. PIPE SUPPORT SYSTEMS

1. General:

   a) No attempt has been made to show all required pipe supports in all locations. The absence of pipe supports and details on Contract

Documents shall not relieve Contractor of the responsibility for providing them where required.

b) Provide pipe supports as indicated.

c) Pipe support, not equipment, shall support pipe at piping connections.

d) Provide pipe clamp or guide at each support.

e) No punched strap, wire, or other makeshift devices will be accepted. Except as otherwise provided herein, all supports shall be commercially produced finished products.

f) Hot dip galvanize all exposed hangers, rods, clamps, protective shields, metal framing support components, and hanger accessories.

g) Submerged or potentially submerged (i.e., below grade or within a vault) structure fastening components (i.e. nuts and bolts): Type 316 stainless steel, or Approved Equal, on stainless steel Type 316 supports.

2. Vertical Pipe Supports:

a) Where exposed pipes change from horizontal to vertical, support pipes on the horizontal runs within 1 feet of the change in direction.

b) For vertical runs exceeding 10 feet, support pipes by a base elbow, if applicable.

c) Unless otherwise indicated, support all vertical pipes at intervals of no more than 10 feet, on wall rests, and at all points necessary to ensure rigid construction.

3. Special Supports:

a) Provide special adjustable supports for the flow meter and motor-operated butterfly valve capable of supporting 150% of the weight of the meter/valve, as appropriate.

b) Provide supports on all pipes and appurtenant equipment, as appropriate, to prevent movement or over-stressing of materials resulting from the seismic forces defined by the California Building Code.

c) Unless otherwise indicated, fabricate or construct supports from standard structural steel shapes, concrete, and anchor hardware similar to items previously specified herein and subject to the approval of Owner.

D. UNDERGROUND PIPE TRACER WIRE

1. Provide tracer wire for all buried pipelines, except concrete cylinder pipe and gravity flow drain lines, for location identification.

2. Lay number 12 THHN insulated copper wire on top of and along the entire length of all buried pipelines.
3. Extend wire a minimum of 6 inches with 2- to 3-inch pigtail above grade at all points of access, valves, valve boxes, vaults, air valves, blow-offs, junction boxes, and pull-boxes; where pipelines rise above grade; and where pipelines penetrate into buildings.
4. Provide one tracer wire for pipes that are bundled together in a common trench.
5. Make all wire connections with copper crimps wrapped with electrical tape.
6. Provide different color wire insulators for the various utilities involved.
7. Color coding: as approved by Owner prior to installation.

E. WARNING TAPE

1. General:
   a) Provide for all buried pipelines.
2. Materials:
   a) Specifically manufactured for warning and identification of buried piping.
   b) High-quality polyethylene base material having a minimum tensile strength of 1500 psi.
   c) Resistant to acids, alkali, and other detrimental substances normally found in soils.
   d) Minimum thickness: 0.004 inches
   e) Minimum width: 6 inches
3. Labeling and Coding:
   a) Permanent and unaffected by moisture and other substances contained in trench backfill material.
   b) Provide appropriate color-coding for the utilities involved with warning, as approved by Owner.
   c) Imprinted with bold black lettering labeling the utility involved with warning.

F. PIPE FLANGES

1. Flanges:
   a) Unless otherwise indicated, conform to ANSI/AWWA C207 Class E for 275 psi service.
   b) Flat faced.

c) Attached with bolt holes straddling the vertical axis of the pipe unless otherwise indicated.

d) Attachment to the pipe shall conform to the applicable requirements of ANSI/AWWA C207.

2. Blind flanges:

a) In accordance with ANSI/AWWA C207, or with the standards for miscellaneous small pipes.

b) Pressure rating: equal to that of companion flange.

3. Flange coating:

a) All machined faces of metal blind flanges and pipe flanges

b) Temporary rust-inhibitive coating to protect the metal until the installation is completed.

4. Flange bolts and nuts:

a) Manufacturers for flange bolts and nuts:

(1) Tripac Fasteners

(2) Zero Products, Inc.

(3) Or Approved Equal

b) Extend studs and bolts through and beyond the nuts a minimum of 1/4 inch and no more than 1/2 inch

c) All bolts, studs, washers, and nuts: in accordance with ANSI/ASME B18.2.1.

d) All bolts and nuts:

(1) In accordance with ASTM designation A307-94, Grade B, having a minimum tensile strength of 60,000 psi.

(2) In underwater service applications (including wet trench conditions resulting from groundwater): Type 316 stainless steel with 316 stainless steel stamped on the head of the bolt.

e) Nuts:

(1) ASTM designation A563-94, Grade A, heavy hexagon pattern.

(2) Stainless steel nuts for stainless steel bolts.

f) Coating for carbon steel nuts and bolts:

(1) Fluoropolymer coating over a corrosion-resistant undercoating base material such as nickel.

(2) Specially manufactured as a protective coating system for threaded connections.

(3) Corrosion resistant

(4) Low coefficient of friction.

(5) Abrasion resistant.

5. Flange gaskets:

a) Manufacturers:

(1) John Crane, Style 2160

(2) Garlock

(3) Klinger

(4) Or Approved Equal

b) 1/8-inch thick material in accordance with ANSI/AWWA C207, Section 4.1.3 "Gaskets" and the accompanying Table 1.

c) Non-stick coating.

d) Blind flanges:

(1) Covering the entire inside face of the blind flange.

(2) Cemented to the blind flange.

e) NSF/ANSI 61 approved for potable water service.

6. Flange insulating joints:

a) Manufacturers:

(1) Calpico

(2) Pipeline Seal and Insulation, Inc (PSI)

(3) Or Approved Equal

b) Include non-conductive full-faced gaskets and sleeves and washers for the bolts.

G. THREADED INSULATING CONNECTIONS

1. General:

a) Use threaded insulating bushings, unions, or couplings, as appropriate, for joining threaded pipes.

2. Materials:

a) Nylon, Teflon®, polycarbonate, polyethylene, or other equal non-conductive materials approved by Owner.

b) Ratings and properties: suit the service and loading conditions.

H. PIPE THREADS

1. National Pipe Threads (NPT) in accordance with ANSI/ASME B1.20.1

I. VALVES

1. Same size as the pipelines in which they are installed, unless specifically sized differently.
2. Pressure rating:
   a) Appropriate for the piping system in which valve is installed.
   b) 250 psi working pressure, unless otherwise indicated.

J. THREAD-O-LETS

1. Material: match material being welded to.

K. SOURCE QUALITY CONTROL

1. Factory Quality Control:
   a) In accordance with manufacturer’s test procedures.
2. Inspection:
   a) Pipe, fittings, and appurtenances, after the manufacturer has performed satisfactory checks, adjustments, tests, and operations.
   b) As specified herein and in the respective piping sections of these Specifications.
   c) Make available for Owner's use such tools as are necessary for inspection.

PART 3 EXECUTION

3.01

A. GENERAL

1. Provide all necessary materials to make connections to existing pipes.
2. Pressurized lines:
   a) Unless otherwise indicated, lay flat or with a continuous grade so that there will be no air traps or humps, except at the ends.
   b) Provide means for venting at the ends of pipe runs and at all high points in liquid filled pipes.
   c) If approved by Owner, provide concrete thrust blocks and anchors in trenches in lieu of restrained pipe joints at bends, tees, wyes, ends, changes in pipe size and other locations subject to thrust movement.
3. Insulated Joints:
   a) Provide where indicated.
   b) Unless otherwise approved by Owner:
      (1) Provide between embedded (buried) and non-embedded conditions.

(2) Provide between new pipe and existing pipe.

(3) Provide between interior and exterior pipe.

(4) Provide between dissimilar material pipes.

4. Protect all joints.

5. Repair any damage to coating or lining of the pipe and/or fittings.

B. EXCAVATION AND TRENCHING

1. See Section 02320 (Trenching, Backfilling, and Compacting for Utilities).

C. INSTALLATION

1. General:

a) Assemble pipe and fittings to ensure accurate alignment of joints.

b) Anti-seize compound

(1) Use on all stainless steel bolt threads.

(2) Apply in accordance with manufacturer's instructions.

(3) Designed to prevent seizure of bolt threads and to prevent galling of stainless steel.

c) Make all joints watertight for hydrostatic test pressures.

d) Provide temporary watertight plugs, caps, or bulkheads for closure of the open ends of piping whenever Work is stopped.

e) Install pipe in precast concrete structures in the center of the pre-formed hole in the structure. After installation of the pipe, and before backfilling, fill the annular space around the pipe with a non-hardening elastomeric material approved by Owner.

f) Caulking of screwed joints, cracks, or holes will not be accepted. Repeat tests after defects have been eliminated.

2. Preparation:

a) Inspect all pipes and fittings prior to installation.

b) Inspect lining and protective coating and repair all damaged areas in the field with material similar to the original coating.

c) Clean ends of pipe thoroughly.

d) Remove foreign matter and dirt from inside of pipe and keep clean during and after laying.

e) Clean out fittings, valves, and pipe sections before installing.

3. Buried Pipe:

a) Provide and maintain ample means and devices at all times to remove and dispose of all water entering the trench during the

process of pipe laying in accordance with Section 02240 (Dewatering).

b) Keep trench dry until the pipe laying and jointing are completed.

c) When the pipe laying is not in progress, including meal-break hours, close the open ends of pipe by approved means, and ensure no trench water, animals, or foreign material enters the pipe.

d) Minimum pipe cover in the trench: 3 feet, unless otherwise indicated.

e) Except as otherwise indicated, lay buried pipe on the prepared bedding material to ensure uniform bearing.

f) No pipe shall be laid in water or when, in the sole opinion of Owner, trench conditions are unsuitable.

g) Take all precautions necessary to prevent uplift and floating of the pipe prior to backfilling.

h) Connections to concrete structures:

(1) As indicated.

(2) If the connection is not shown, make connection such that a standard pipe joint is located no more than 18 inches from the structure.

i) In the event of conflicts in location or grade or both, between new piping and existing piping, make adjustments in location or grade of new piping as directed by Owner.

j) Install warning tape and tracer wire after bedding is completed and before backfilling begins.

4. Exposed Pipe:

a) Where not detailed, install exposed pipe in straight runs parallel to the axis of the structures.

b) Pipe runs: horizontal and vertical, except that gravity lines shall have a minimum slope of not less than 0.5 percent, unless otherwise specified.

c) Erect no exposed piping until all equipment to which the pipe is to be attached has been installed and the location of piping and fittings can be determined to make a neat, efficient arrangement.

d) Drawings for piping 6 inches in diameter and smaller are diagrammatic. Sizes of piping and their locations are indicated, but the Drawings are not intended to show every offset and fitting nor every structural difficulty that will be encountered during the installation of the Work.

e) Support pipe work in such manner as to prevent sagging or overstressing of pipe and connections and to prevent transfer of any load or stress from piping system to any equipment.

f) Assemble pipe and fittings so there will be no distortion or springing of the pipelines.

g) Piping: made up with a sufficient number of unions or flanged joints to permit ready breaking of lines as necessary for installation, inspection, and maintenance.

h) Provide unions on all threaded connection pipe where the pipe connects to any equipment, where the pipe passes through a wall or floor slab, and at no more than 20-foot intervals.

5. Valves:

a) Install no valve with its stem pointing down, unless specifically indicated.

D. SLAB AND WALL PENETRATIONS

1. Piping penetration of slabs and walls:

a) Verify the size and location of all structure penetrations prior to pouring concrete.

b) Pipe penetrations in existing slabs or walls:

(1) X-ray prior to core drilling to avoid the reinforcing steel.

c) Annular Space Sealant Material:

(1) Drainage and electrical structures: Class A non-shrink grout.

(2) Above-ground structure penetrations: Class A non-shrink grout.

(3) All other structures/applications: Watertight Elastomeric Non-Hardening Sealant Material, unless otherwise approved by Owner.

E. HYDROSTATIC TESTING

1. General:

a) Conduct hydrostatic tests on all newly installed pipelines, excluding non-pressurized gravity-drained pipelines.

b) Furnish all necessary equipment, instrumentation, and material including temporary plugs, bulk heads, and blind flanges and make all taps in the pipe, as required.

c) Testing against closed valves will not be permitted.

d) No direct connections to the existing water supply system will be permitted. Prior to testing, dismantle any connections that may have been used to fill the pipeline with water.

e) Hydrostatic testing water: Chlorine residual concentration shall be less that one part per million.

f) Owner will witness the tests.

g) Pipe provided with concrete thrust blocking:

(1) Do not make the pressure test until at least 5 Days have elapsed after the thrust blocking is installed.

(2) If high-early cement is used, the time may be reduced to 3 Days.

h) Slowly fill the section of pipe to be tested with water and allow to stand for 24 hours under slight pressure to allow the pipe to accommodate swelling/absorption. Refill with makeup water before test.

i) Conduct the tests on piping after the piping has been completely installed, including all supports, hangers, and anchors.

j) Expel all air from the piping system prior to testing and apply and maintain the test pressure hereinafter specified by means of a hydraulic force pump.

k) Valve off the piping system when the test pressure is reached and conduct the pressure test for 4 hours.

l) Make repairs of defects that are discovered as a result of testing with new materials. Caulking of screwed joints, cracks, or holes will not be accepted.

m) Repeat tests after defects have been eliminated at no additional cost to Owner.

n) Test pressure:

(1) Unless otherwise indicated or approved: 250 psi.

o) Perform hydrostatic test with a 0-300 psi gauge (accurate to +/- 0.25 percent full gauge reading, and recently calibrated) direct connected to the pipeline (minimum 6-inch diameter dial size).

2. Leakage: zero at the test pressure specified throughout the duration of the hydrostatic test.

3. Acceptable pressure drop: zero.

4. Test new pipelines which are to be connected to existing pipelines by isolating the new pipe.

5. Testing of the pipeline may be performed in segments approved by Owner.

F. CLEANING

1. Exercise care during installation to prevent the accumulation of weld rod, weld splatter, pipe cuttings and filings, gravel, cleaning rags, etc., within piping sections.
2. Examine all piping to assure removal of these and other foreign objects prior to assembly.
3. Use approved cleaning method.
4. Following assembly and testing, but prior to Final Acceptance, clean the full interior of all pipelines by flushing with high-velocity water or using a cleaning ball. Broom sweep large diameter pipes (larger than 24 inches) prior to flushing.
5. Flushing velocities:
   a) Diameter less than 24 inch: minimum of 2.5 feet per second for the full cross-section of the pipe.
   b) Diameter greater than or equal to 24 inch: Wash down flushing may be used in lieu of full cross-section flow flushing, as approved by Owner.
6. Remove accumulated dirt and debris.
7. Perform flushing until all foreign material is removed, the water is clear, and the nephelomatic turbidity unit (NTU) is 0.2 or less.

END OF SECTION

SECTION 15103

PRESSURE SUSTAINING VALVES

PART 1 – GENERAL

1.1 DESCRIPTION

A. This section includes materials, performance testing, and installation of pressure sustaining control valves.

B. Reference Sections:
   a. Section 15051 – Basic Piping Materials and Methods

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Except as otherwise indicated, the current editions of the following standards apply to the Work of this section:

1.	ANSI/ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings
2.	ANSI/ASME B16.5	Pipe Flanges and Flanged Fittings
3.	ANSI/ASME B16.47	Large Diameter Steel Flanges: NPS 26 through 60
4.	ANSI/ASME B1.20.1	Pipe Threads (Inch), General Purpose
5.	ANSI/ASME B31.1	Power Piping
6.	ASTM A36	Standard Specification for Carbon Structural Steel
7.	ASTM A48	Standard Specification for Gray Iron Castings
8.	ASTM A126	Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
9.	ASTM A216	Standard Specification for Steel Castings, Carbon Suitable for Fusion Welding for High Temperature Service
10.	ASTM A351	Standard Specification for Steel Castings, Austenitic, Austenitic-Ferric (Duplex), and Pressure-Containing Parts
11.	ASTM A395	Standard Specification for Ferritic Ductile Iron Pressure Retaining Castings for Use at Elevated Temperatures
12.	ASTM A515	Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate and Higher Temperature Service
13.	ASTM A536	Standard Specification for Ductile Iron Castings

14.	ASTM A743	Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion-Resistant, for General Purposes
15.	ASTM B61	Standard Specification for Stream or Valve Bronze Castings
16.	ASTM B62	Standard Specification for Composition Bronze or Ounce Metal Castings
17.	ASTM B148	Standard Specification for Aluminum-Bronze Sand Castings
18.	ASTM B584	Specification for Copper Alloy Sand Castings for General Applications
19.	ANSI/AWWA C210	Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
20.	ANSI/AWWA C512	Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service
21.	ANSI/AWWA C550	Protective Epoxy Interior Coatings for Valves and Hydrants
22.	SSPC SP 2	Hand Tool Cleaning
23.	SSPC SP 5	Joint Surface Preparation White Metal Blast Cleaning
24.	MSS SP25	Standard Marking Systems for Valves, Fittings, Flanges and Unions

1.3 SUBMITTALS

A. The following submittals are required:

1. Submit Shop Drawings, manufacturer's catalog data and detail construction sheets showing all valve parts and describing material of construction by material and specification (such as AISI, ASTM, SAE, or CDA). Submittal shall include valve dimensions including laying lengths and dimensions and orientation of valve operators. Information shall be submitted on valve handles, handwheels, position indicators, limit switches, integral control systems, needle valves, and control systems. Submittals shall also indicate valve linings and coatings with manufacturer's and paint numbers listed. Contractor shall indicate the size, quantity and pressure rating of valves, including the class and drilling pattern of the flanges where applicable.

B. Manufacturer's certification that products comply with the requirements set forth in the Contract Documents.

C. Manufacturer's certification that all linings and coatings have been factory tested and comply with the indicated requirements, including NSF certification for all coating systems.

D. Data for electric motor-operated valves.

E. Complete wiring diagrams and control system schematics.

F. A schedule of valves to be labeled, indicating in each case the valve location and the proposed wording for the label.

G. For valves requiring certified tests, submit certified test results.

H. Operation and maintenance data shall be submitted and shall include, but not be limited to, the following information:

1. Manufacturer's installation and operating instructions.
2. Manufacturer's maintenance procedures.
3. List of special tools.
4. Schedule of valves indicating valve identification and location.
5. Spare Parts List: A spare parts list shall be provided with information for each valve assembly.
6. Factory Test Data: Where indicated, signed, dated, and certified factory test data for each valve requiring certification shall be submitted before shipment of the valve. The data shall also include certification of quality and test results for factory-applied coatings.

PART 2 – MATERIALS

2.1 GENERAL

A. All valves shall be new and of current manufacture. Valves shall be furnished and installed by the Contractor at the location and in accordance with the type of ends as shown on the Drawings and as herein specified.

B. The manufacturer shall have manufactured tight-closing valves of the valve type intended for use for a period of at least five years.

C. The Contractor shall furnish and install each specific type of valve from a single manufacturer and use it throughout the Work.

D. All valves shall have a rated working pressure of at least 150 psi. All valves shall be certified to meet the test pressure as specified and shall have a rated working pressure that exceeds the full working pressure specified.

E. Connections: Valves shall have flanged, hub, screwed, or special connector ends as shown on the Drawings. Where not indicated, the valves shall have the same type of connection as the pipeline in which valves are to be installed and conform to the Specifications.

F. Bolts, Nuts and Washers: Bolts, nuts and washers shall be stainless steel.

G. All aboveground bolt threads shall be lubricated with graphite and oil. Flanged faces shall be wire brushed and cleaned prior to joining each flange.

H. Painting and Coating: All valves referenced in this section shall be factory fusion bonded epoxy coated, interior and exterior.

I. "Tying" of equipment into packages for the purpose of thwarting competition shall be considered to be in non-compliance with these specifications. Manufacturers shall price items under different subsections or sections separately.

J. The valve manufacturer shall warrant the valve to be free of defects in material and workmanship for a period of one year from date of shipment, provided the valve is installed and used in accordance with all applicable instruction. Electrical components shall have a one-year warranty.

K. A direct factory representative shall be made available for start-up service, inspection and necessary adjustments.

2.2 PRESSURE SUSTAINING VALVE

A. Function. The pressure sustaining valve is designed for installation on the end of the pipeline, where the pipe is open to atmosphere, to sustain upstream pressure to at least 30 psi.

B. Main Valve. The valve shall be hydraulically operated, single diaphragm-actuated, globe or angle pattern. The valve shall consist of three major components: the body with seat installed, the cover with bearings installed, and the diaphragm assembly. The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating operating pressure from line pressure. Packing glands and/or stuffing boxes are not permitted and there shall be no pistons operating the main valve or pilot controls.

C. The valve shall contain a resilient, synthetic rubber disc with a rectangular cross-section contained on three and one-half sides by a disc retainer and forming a tight seal against a single removable seat insert. No O-ring type discs (circular, square, or quad type) shall be permitted as the seating surface. The disc guide shall be of the contoured type to permit smooth transition of flow and shall hold the disc firmly in place. The disc retainer shall be of a sturdy one-piece design capable of withstanding opening and closing shocks. It must have straight edge sides and a radius at the top edge to prevent excessive diaphragm wear as the diaphragm flexes across this surface. No hourglass-shaped disc retainers shall be permitted and no V-type or slotted type disc guides shall be used.

D. The diaphragm assembly containing a non-magnetic 303 stainless steel stem of sufficient diameter to withstand high hydraulic pressures shall be fully guided at both ends by a bearing in the valve cover and an integral bearing in the valve seat. The seat shall be a solid, one-piece design and shall have a minimum of a five-degree taper on the seating surface for a positive, drip-tight shut off. No center guides shall be permitted. The stem shall be drilled and tapped in the

cover end to receive and affix such accessories as may be deemed necessary. The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve separating operating pressure from line pressure.

E. The main valve seat and the stem bearing in the valve cover shall be removable. Valve seat in 8" and larger size valves shall be retained by flat head machine screws for ease of maintenance. The lower bearing of the valve stem shall be contained concentrically within the seat and shall be exposed to the flow on all sides to avoid deposits. To insure proper alignment of the valve stem, the valve body and cover shall be machined with a locating lip. No "pinned" covers to the valve body shall be permitted. Cover bearing, disc retainer, and seat shall be made of the same material. All necessary repairs and/or modifications other than replacement of the main valve body shall be possible without removing the valve from the pipeline. Packing glands and/or stuffing boxes shall not be permitted.

F. The flexible, non-wicking, FDA approved diaphragm shall consist of nylon fabric bonded with synthetic rubber compatible with the operating fluid. The center hole for the main valve stem must be sealed by the vulcanized process or a rubber grommet sealing the center stem hole from the operating pressure. The diaphragm must withstand a Mullins Burst Test of a minimum of 600 psi per layer of nylon fabric and shall be cycle tested 100,000 times to insure longevity. The diaphragm shall be fully supported in the valve body and cover by machined surfaces which support no less than one-half of the total surface area of the diaphragm in the either the fully open or fully closed position.

G. The valve shall be capable of being upgraded in the future to an electronic control valve.

H. Pilot System Components: The pressure relief pilot shall be a direct-acting, adjustable, spring-loaded, diaphragm valve designed to permit flow when controlling pressure exceeds the adjustable spring setting. The pilot control is normally held closed by the force of the compression on the spring above the diaphragm and it opens when the pressure acting on the underside of the diaphragm exceeds the spring setting. Pilot control sensing shall be upstream of the pilot system strainer so accurate control may be maintained if the strainer is partially blocked. A full range of spring settings shall be available in ranges from 0-450 psi.

I Material Specification

1.	Valve Size:	12-inch
2.	Main Valve Body and Cover:	Ductile Iron ASTM A536
3.	Main Valve Trim:	316 Stainless Steel Anti-cavitation
4.	End Detail:	Flanged, ANSI B16.1, Class 150
5.	Pressure Rating:	150 PSI
6.	Temperature Range:	180°F (max)

7.	Rubber Material:	Buna-N Rubber
8.	Coatings:	Heat Fusion Bonded Epoxy Internally & Externally
9.	Pilot System Components:	Bronze
10.	Tubes and Fittings:	Stainless steel
11.	Body Studs and Cover Nuts:	Stainless Steel
12.	Inlet pressure Gauge:	0 – 100 psi

N. Performance Specification

1.	Adjustment Range:	0 – 75 psi

O. Approved Products: Cla-Val Model 50G-01BPKCO or approved equal.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Flanges shall be cleaned by wire brushing before installing flanged valves. Flange bolts and nuts shall be cleaned by wire brushing, and threads lubricated with oil and graphite. Nuts shall be tightened uniformly and progressively. If flanges leak under pressure testing, nuts and bolts shall be loosened or removed, the gasket reseated or replaced, the bolts and nuts reinstalled or retightened, and joints retested. Joints shall be watertight.

B. Threaded joints shall be cleaned by wire brushing or swabbing. Teflon joint compound or Teflon tape shall be applied to pipe threads before installing threaded valves. Joints shall be watertight.

C. All valve exhausts shall be piped to nearest area drain with stainless steel pipe. Provide unions as required for maintenance and valve removal.

3.2 VALVE PRESSURE TESTING

A. Valves delivered to the site prior to successful hydrostatic testing and holiday detection will be subject to rejection. Valves shall be hydrostatically tested in conjunction with the pipeline in which it is connected in accordance with these Specifications.

3.3 COATING AND TESTING

A. The interior of the valves shall be epoxy lined at the factory. The lining system shall be listed in the NSF Listing for Drinking Water Additives, Standard 61, certified for use in contact with potable water. The minimum dry film thickness for epoxy lining shall be 8 mils applied in two coats. Surface preparation shall be as detailed in SSPC-SP5, White Metal Blast Cleaning.

B. The valves shall have the manufacturer's standard coating on the exterior. Factory coating shall be suitable for epoxy coating over original coating.

C. Valve lining and coating shall be holiday free. Holiday testing and dry film thickness testing shall be conducted at the factory.

D. Valves shall be hydrostatically tested at the factory for the full pressure classification. Hydrostatic testing shall be performed after the interior and exterior coatings have been applied and successfully tested.

E. Each valve and actuator assembly shall be operated through a complete cycle (fully closed to fully open to fully closed positions) prior to shipment.

F. Prior to shipment, the manufacturer shall submit notarized certification that each valve supplied has successfully completed the tests required by this specification.

END OF SECTION

SECTION 15112

BUTTERFLY VALVES

PART 1 GENERAL

1.01

A. SUMMARY

1. Related Sections:

a) Section 15185 (Motor Operators)

B. REFERENCES

ANSI/AWWA C207	Steel Pipe Flanges for Waterworks Service – Sizes 4 inch through 144 inch.
ANSI/AWWA C504	Rubber Seated Butterfly Valves
ANSI/AWWA C550	Standard for Protective Epoxy Interior Coatings for Valves and Hydrants
ASTM A564	Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes
NSF/ANSI 61	Drinking Water Systems Components – Health Effects

C. SUBMITTALS

1. Product Data:

a) Butterfly valves, including head loss chart or curve showing the head loss through the valve as a function of the flow through the valve.

b) Protective coating for valve interior and exterior

2. Shop Drawings:

a) Butterfly valve

3. Quality Assurance/Control Submittals:

a) Test Reports:

(1) ANSI/AWWA C504, Section 5.2:

(a) Performance Test

(b) Leakage Test

(c) Hydrostatic Test

b) Certificates:

(1) Furnish a manufacturer-certified statement that proof of design tests as stated in ANSI/AWWA C504, Section 5.2.4 were successfully performed on similar types of valves, in the sizes specified herein, within the past two years.

c) Manufacturer's Instructions:

(1) Butterfly valve installation

4. Installation, Operation, and Maintenance Manual:

a) Butterfly valves

PART 2 PRODUCTS

2.01

A. MANUFACTURERS

1. DeZurik
2. Henry Pratt Company, HP 250
3. Or Approved Equal.

B. MANUFACTURED UNITS

1. Butterfly Valves:

a) Rated for 250 psi working pressure

b) In accordance with applicable requirements of ANSI/AWWA C504, except as modified for 250 psi service

c) Flanged:

(1) Minimum 275 psi working pressure rating

(2) Compatible with Class E in accordance with ANSI/AWWA C207

d) Short body

e) Normal liquid velocity 4-6 feet/second; maximum liquid velocity 16 feet/second

f) Maximum head loss allowed:

(1) 54" valve: 0.25 feet at 43,800 GPM

g) Materials:

(1) Body and disc: Cast iron or ductile iron

(2) Valve seat: Buna-N rubber

(3) Seating edge for disc: Nickel chrome or stainless steel

(4) Valve shaft: Stainless steel ASTM A564

(5) Valve shaft connecting taper pins: Stainless steel

(6) Valve bearings: Corrosion resistant material, sleeve type

(7) Shaft seals: Self-adjusting split V packing

h) Seats contained in the body, vulcanized directly to the valve body 360 degrees around the valve body, or installed in an undercut

dovetail groove integrally cut 360 degrees around in the valve body.

2. Embedded Butterfly Valves:
   a) Designed for buried service
   b) Manual operator with 2-inch nut
   c) Operator designed for 150% of the maximum torque required to open or close the valve.
3. Non-Embedded Butterfly Valves (in vault):
   a) Designed for non-embedded service
   b) Designed to accommodate motor operator indicated in Section 15185 (Motor Operators)
   c) Operator designed for torque requirements of ANSI/AWWA C504

C. FINISHES

1. Shop Surface Preparation:
   a) In accordance with the printed application instructions provided by the protective coating manufacturer.
2. Shop Finishing:
   a) Interior
      (1) Epoxy lining material per ANSI/AWWA C550
      (2) NSF/ANSI 61 approved
   b) Exterior:
      (1) Epoxy lining material per ANSI/AWWA C550
      (2) NSF/ANSI 61 approved

D. SOURCE QUALITY CONTROL

1. Tests per ANSI/AWWA C504, Section 5.2:
   a) Performance Test
   b) Leakage Test by alternate hydrostatic method and in both directions, except test at 250 psi
   c) Hydrostatic Test

PART 3 EXECUTION

3.01

A. INSTALLATION

1. Install per manufacturer's installation instructions.

B. FIELD QUALITY CONTROL

1. Manufacturers' Field Services

a) Provide services of a factory-authorized Technical Service Representative for one Day to supervise installation of the valves.

END OF SECTION

SECTION 15115

AIR VALVES

PART 1 GENERAL

1.01

A. SUMMARY

1. Section Includes:
   - a) Air valves
   - b) Air valve enclosure
   - c) Wood poles for air valve vent pipes

B. REFERENCES

NSF/ANSI-61	Drinking Water Systems Components – Health Effects
ANSI 05.1	Wood Poles - Specifications and Dimensions
AWPA P8	Standard for Oil-Borne Preservatives
AWPA C4	Poles - Preservative Treatment by Pressure Processes

C. SUBMITTALS

1. Product Data:
   - a) Air valves
   - b) Wood poles
2. Shop Drawings:
   - a) Air valves
   - b) Wood poles
3. Quality Assurance/Control Submittals:
   - a) Tests:
     - (1) Air valves:
       - (a) Factory pressure test
   - b) Manufacturer's Instructions:
     - (1) Air valve installation
4. Installation, Operation and Maintenance Manual:
   - a) Air valves

PART 2 PRODUCTS

2.01

A. MANUFACTURERS

1. Air valves:

a) Vent-O-Mat, Series RBX, except as follows:

(1) Vent-O-Mat Series RC shall be used for the air valve located in the motor-operated valve vault.

b) No Substitutions

2. Air valve enclosure:

a) Pipeline Products, Model VC-316D

b) Or Approved Equal.

B. MANUFACTURED UNITS

1. Air Valves:

a) General:

(1) Ratings:

(a) Working water pressure: From 100 psi through 250 psi.

(b) Field test pressure: 250 psi for all air valves.

(2) 2-inch or 8-inch nominal size, as indicated.

(3) Intake orifice size equal to the nominal size of the valve

(4) End connections:

(a) 2″ valve: 2″ NPT inlet and outlet

(b) 8″ valve:

(i) flanged inlet and outlet

(ii) 8-inch diameter 90-degree flanged elbow outlet fabricated integrally with air valve by manufacturer and having same lining/coating as air valve.

(5) Test cock:

(a) 1/4-inch female NPT on lower flange assembly

b) RBX Air valves:

(1) Function:

(a) Single chamber design

(b) Combination air release and air vacuum valve with surge and waterhammer protection. Function as an

air release valve to discharge small quantities of air during normal operations and large quantities of air when filling the pipeline, and to admit air into the pipeline when the pressure in the pipeline becomes less than atmospheric pressure.

(c) Leak tight up to 500 psi.

(2) Materials:

(a) Floats: High density polyethylene

(b) Body: Tubular stainless steel body with cast iron or steel ends and stainless steel tie rods.

c) RC Air Valves:

(1) Function:

(a) Double-orifice air release and vacuum break valve for high-volume air discharge, high-volume air intake, and pressurized air discharge.

(b) Double acting.

(2) Materials:

(a) Body: Cast iron.

(b) Coating: Epoxy powder coat.

(c) Floats: High-density polyethylene.

(d) Seals: Nitrile.

2. Air Valve Enclosure:

a) Galvanized construction.

b) Fabricate to provide minimum 1-inch gap between concrete pad and bottom of enclosure to allow for drainage of water.

c) Mount directly to concrete pad with anchor bolts.

(1) Anchor bolts: Minimum 4

3. Wood pole (for vent pipe support):

a) Class 1 conforming to ANSI 05.1

b) New pole (not previously used)

c) Type:

(1) Pacific coast Douglas Fir (Fir)

(2) Western red cedar (Cedar)

(3) Or Approved Equal

d) Preservative: oil-borne copper napthenate in accordance with AWPA P8

e) Treatment: full-length pressure treated in accordance with AWPA C4

C. FINISHES

1. Shop Finishing:

a) NSF/ANSI 61 approved

b) Cast iron: Epoxy lined and coated

PART 3 EXECUTION

3.01

A. INSTALLATION

1. Install as indicated and per the manufacturer's installation instructions.

2. Install air valves plumb.

END OF SECTION

SECTION 15118

MISCELLANEOUS VALVES

PART 1 GENERAL

1.01

A. SUMMARY

1. Section Includes:

a) Gate Valves

b) Ball Valves

c) Corporation Stops

d) Check Valves

e) Other valves not specified elsewhere

B. REFERENCES

ASTM B 62	Standard Specification for Bronze or Ounce Metal Castings
AWWA C509	Resilient Seated Gate Valves for Water Supply Service
NSF 61	Drinking Water System Components – Health Effects

C. SUBMITTALS

1. Product Data:

a) Gate valves

b) Ball valves

c) Corporation stops

d) Check valves

e) Other valves not specified elsewhere

2. Quality Assurance/Control Submittals:

a) Manufacturer's instructions:

(1) Installation instructions for all valves

3. Installation, Operation, and Maintenance Manual:

a) Gate Valves

b) Ball valves

c) Corporation Stops

d) Check Valves

e) Other valves not specified elsewhere

PART 2 PRODUCTS

2.01

A. MANUFACTURERS

1. Gate Valves:

a) 4 inch and larger:

(1) M&H

(2) Mueller

(3) Or Approved Equal

b) 2 inch and smaller:

(1) Crane

(2) Stockham

(3) Walworth

(4) Or Approved Equal

2. Ball Valves:

a) Mueller, 300 Ball curb valve

b) Ford, Ball valve curb stop

c) Or Approved Equal

3. Check Valves:

a) Red Valve Co., TIDEFLEX Series TF-2

b) Or Approved Equal

4. Corporation Stops:

a) Mueller 300, Ball Corporation Valve

b) Ford Ballcorp

c) Or Approved Equal

B. MANUFACTURED UNITS

1. General:

a) Items in contact with potable water: NSF 61 approved.

b) Pressure rating: Unless otherwise indicated, the minimum working pressure rating of all miscellaneous valves shall be 250 psi.

c) Materials: The material of the body of the valve shall be the same material as the piping connecting to the valve, unless otherwise indicated. If the valve material is different than the piping

material, provide insulating units between the valve and the piping.

d) Size: Unless otherwise indicated, the size of the valve shall be the same nominal size as the piping into which it is being installed.

e) Connections: Unless otherwise indicated, thread the connection for sizes up to 3-inch, and flange for sizes over 3-inch.

f) Direction of operation: Close valves by turning the handle clockwise.

g) Marking: Mark valves on the outside with manufacturer's name, pressure rating, and nominal size.

2. Gate Valves:

a) Comply with AWWA C509.

b) Non-rising stem

c) Manual operator with 2" nut

d) Flanged ends

e) Designed for buried service

3. Ball Valves:

a) Full port opening

b) Threaded ends, NPT

c) Compatible with adjacent piping

d) Drip-tight closure under required rated working pressure

e) 90 degrees open to close

4. Corporation valves:

a) Threaded ends, NPT

b) Compatible with adjacent piping

c) Heavy cast bronze/brass body per ASTM B 62

d) Drip-tight closure under required rated working pressure

e) 90 degree open to close

5. Check valves:

a) Prevent reverse flow

b) Show the direction of flow on check valves

c) Stainless steel mounting bands

PART 3 EXECUTION

3.01

A. INSTALLATION

1. All valves:

a) Install in accordance with the manufacturer's installation instructions and as indicated.

END OF SECTION

SECTION 15141

STEEL PIPE, BLACK AND GALVANIZED

PART 1 GENERAL

1.01

A. SUMMARY

1. Section Includes:

a) Steel pipe 8 inches in diameter and smaller.

B. REFERENCES

ASTM A53	Specification for Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless
ANSI/AWWA C207	Steel Pipe Flanges for Waterworks Service, 4”- 144”
NSF/ANSI 61	Drinking Water System Components – Health Affects

C. SUBMITTALS

1. Shop Drawings:

a) Lay drawings of the piping system.

b) Shop drawing of each component piece of the piping system showing:

(1) Mark Number of the piping component

(2) Pipe wall thickness

(3) Length, or special fabrication dimensions

(4) End connection (if flanged, provide full details, i.e.: flange pressure class or rating, thickness, OD, bolt circle, number of bolts, bolt hole diameter, etc.)

(5) Appurtenances (Threadolets, special fittings, attached pipe support, etc.)

(6) Shop lining including surface preparation and lining material number of coats, dry film thickness (DFT)

(7) Shop coating (surface preparation and coating material number of coats, DFT)

(8) Calculations for special items such as crotch plates, reinforcement plates, supports for thrust harness assemblies, etc.

D. DELIVERY, STORAGE, AND HANDLING

1. Packing, Shipping, Handling, and Unloading

a) All pipe 4-inch and larger to be marked with Mark No.

b) All pipe 4-inch and larger to have ends sealed with plastic material.

c) Protect coating material from transit damage.

2. Acceptance at Site

a) Protective coating material to be undamaged.

3. Storage and Protection

a) Keep stored pipe clean.

b) Protect ends until installed.

PART 2 PRODUCTS

2.01

A. MATERIALS

1. General

a) All pipe to be in accordance with ASTM A53, type E or S, Grade A or B.

b) All pipe and pipe fittings:

(1) Schedule 40, unless otherwise indicated

(2) Minimum pressure rating of 250 psi working pressure

c) Pipe to be shop fabricated to allow for site construction tolerances of +/- 1-inch per every direction of pipe run. Critical flanges are to be shipped loose and field welded into position.

d) Unless otherwise indicated, all steel piping smaller than 4-inches shall be screwed joint; all piping 4-inches and larger shall be flanged joint.

e) Pipe to be supported by pipe supports as shown on the drawings. Pipe fabricator to provide pipe supports.

2. Black (bare/painted) Pipe

a) Unless otherwise indicated, all pipe larger than 4-inch nominal diameter shall be black (bare/painted) pipe.

b) All pipe in this section is to be shop coated in accordance with Section 2.01B Finishes.

3. Galvanized Pipe

a) All pipe not indicated as black pipe (above), shall be galvanized.

b) Galvanizing shall be per paragraph 19, Galvanized Pipe, of ASTM A53.

B. FINISHES

1. Pipe 6 inch and larger: shop prime; pipe 6 inches and smaller: hot dip galvanize.

2. Shop Priming

a) Surface preparation in accordance with printed instructions of manufacturer of prime coating material.

b) Fusion epoxy material, 8-mil thickness dry film thickness, inside and outside of pipe.

c) Coatings in contact with potable water: NSF/ANSI 61 approved.

3. Shop Finishing

a) No shop-applied finish coat required.

PART 3 EXECUTION

3.01

A. INSTALLATION

1. Install per UPC.

END OF SECTION

SECTION 15185

MOTOR OPERATORS

PART 1 GENERAL

1.01

A. SUMMARY

1. Section Includes:

a) Electric motor operators for butterfly valves

B. REFERENCES

AWWA C540 Power Actuating Devices for Valves and Sluice Gates

C. SUBMITTALS

1. Product Data:

a) Electric Motor Operators

2. Shop Drawings:

a) Electric Motor Operators

b) Power and control diagrams

3. Quality Assurance/Control Submittals:

a) Test Reports:

(1) Performance tests per AWWA C540

(2) Proof of design tests

b) Certificates:

(1) Test certifications per AWWA C540

c) Manufacturer's Instructions:

(1) Electric Motor Operator installation

4. Installation, Operation, and Maintenance Manual:

a) Electric Motor Operators

D. QUALITY ASSURANCE

1. General:

a) Verify that the electric motor operator and butterfly valve is fabricated and delivered to the Site as a single integral unit.

2. Certifications:

a) Provide test certifications per AWWA C540.

E. DELIVERY, STORAGE, AND HANDLING

1. Packing, Shipping, Handling, and Unloading:

a) In accordance with AWWA C540

b) In accordance with manufacturers recommendations

PART 2 PRODUCTS

2.01

A. MANUFACTURERS

1. EIM Controls, EIM Company, Inc., Missouri City, TX

a) Series 2000

2. No Substitutions

B. MANUFACTURED UNITS

1. Designed and manufactured in accordance with AWWA C540
2. Manufactured integrally as part of the valve actuator and butterfly valve
3. Open and closing time:

a) 5 minute opening time

b) 5 minute closing time

4. Power supply: 240 VAC, single phase, 60 Hz
5. Enclosure: NEMA 6 submersible
6. Provided with three open-stop-close selector buttons
7. Provided with a lockable local-manual-remote-off selector switch
8. Provided with lights to indicate Open or Closed
9. Provided with a manual hand-wheel that can operate the unit in an override mode
10. Provided with a valve position indicator
11. Rated at 150 percent of the maximum torque required for the butterfly valve
12. Provided with auxiliary contact switches for remote open, close, and stop operation
13. Provided with a valve position transmitter and feedback potentiometer mounted directly to the unit housing for remote indication of the valve (4-20 mA signal)
14. Spare contacts:

a) Provided with two spare normally open contacts for the open position

b) Provided with two spare normally open contacts for the closed position

c) Provided with two spare normally closed contacts for the open position

d) Provided with two spare normally closed contacts for the closed position

e) Wired to an easily accessible terminal strip

f) Rated at 10 amps at 120 VAC

15. Terminals:

a) Provided with an enclosed terminal for wiring remote open-close switches

b) Easily accessible

16. Conduit entries:

a) Provided with separate conduit entries for power and control

b) Control conduit entry: sized for minimum 1 inch conduit

17. Internal heaters:

a) Located within the control compartment of the unit

b) Designed to prevent condensation

c) Provided with a thermal cutout switch in case of motor overload

18. Warning label:

a) located near the manual hand wheel

b) list the maximum number of turns to open or close the valve

C. FINISHES

1. In accordance with AWWA C540

D. SOURCE QUALITY CONTROL

1. Tests:

a) Performance Tests per AWWA C540

PART 3 EXECUTION

3.01

A. INSTALLATION

1. Install in accordance with manufacturer's recommendations and as indicated.

2. Install valve with integral motor operator unit and appurtenances in accordance with the manufacturer's installation instructions and in

accordance with the instructions of the manufacturer's Technical Representative.

B. FIELD QUALITY CONTROL

1. Site Tests:

a) Provide electrical power source.

b) Operate the valve from the full open to full closed position and return using the manual hand wheel.

c) Operate the valve from the full open to full closed position and return using the electric motor operator.

d) Operate the valve from the full open to full closed position stopping the valve in two intermediate positions using the stop button.

e) Demonstrate the limit switches operate at full open and full closed positions

2. Manufacturer's Field Services:

a) Provide two Days of service by a factory-authorized Technical Representative.

(1) One Day during installation

(2) One Day during start up

C. ADJUSTING

1. Adjust motor operators to operate within the parameters specified.

D. DEMONSTRATION

1. Provide 2-hour training for the motor operator and appurtenances.

END OF SECTION

DIVISION 16

ELECTRICAL

SECTION 16050

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.01

A. SUMMARY

1. Section includes:

a) Basic electrical materials and methods for all electrical equipment including, but not limited to, circuit breakers, electrical conduits, wiring (power, control, alarm, signal, and indication), conductor terminating kits and lugs, equipment enclosures, power panelboards, terminal blocks, pull boxes, control panels, nameplates, equipment mounting hardware, warning tape, tracer wire, and excavation and backfill.

2. Related Sections: Section 09900 Painting and Coating.

B. SUBMITTALS

1. Product Data:

a) Circuit Breakers

b) Flow Instruments

c) Conductor Terminating Kits and Lugs

d) Equipment Enclosures

e) Power Panel

2. Shop Drawings:

a) Modifications to existing equipment.

b) Modifications to interconnection wiring shall be prepared by a registered electrical engineer.

3. Quality Assurance/Control Submittals:

a) Manufacturer's Instructions:

(1) Installation of all electrical equipment

b) Evidence that the products submitted meet the requirements of the referenced standards.

c) Evidence that all electrical equipment manufacturers are ISO 9001 Certified.

4. Installation, Operation, and Maintenance Manuals:

a) All electrical equipment, include routine test schedule for all equipment

5. Closeout Submittals:

   a) For all equipment: bill of materials

C. QUALITY ASSURANCE

1. Electrical Drawing Use and Interpretation:

   a) Any error or omissions of detail in either the Drawings or the Specifications shall not relieve Contractor from correctly installing all materials necessary for a complete and operating electrical system.

   b) The electrical Drawings are diagrammatic and shall be followed as closely as existing conditions will permit. All deviations from the Drawings required to make the Work conform to structures as constructed, and to the work of others, shall be made at Contractor’s expense.

   c) Examine the civil, structural, mechanical, and manufacturer's Drawings for the various equipment in order to determine exact routing and final terminations for all conduits and cables. Stub up conduits as near as possible to equipment enclosures.

   d) Examine the Specification and Drawings for mechanical equipment and provide all starters, circuit breakers, switches, pushbuttons, and appurtenances whether or not they are specified. Erect all electrical equipment not specifically stated to be erected by others; furnish and install conduit, wire, and cable; and make connections required to place all mechanical equipment in complete operation.

2. All electrical materials, fabrication, and Work shall conform to following standards, as applicable:

   a) ANSI

   b) AWWA

   c) CBC

   d) CEC

   e) CSA

   f) IEEE

   g) ISA

   h) NEC

   i) NEMA

   j) NESC

   k) NFPA

l) NFPA 101 - Life Safety Code

m) UL

3. All electrical equipment manufacturers shall be ISO 9001 certified.

D. DELIVERY, STORAGE, AND HANDLING

1. Follow manufacturer's recommendations for storage.

2. Deliver materials and equipment to Site in manufacturer's original packaging with labeling showing product name, brand, model, Project name, address, and Contractor's name. Store in a location approved by Owner, secure from weather or accidental damage.

3. Protect electrical materials and equipment from the effects of weather.

4. Prior to installation, store items in clean, dry, indoor locations. Store in clean, dry, indoor, heated locations items subject to corrosion under damp conditions, and items containing electrical insulation, such as transformers, conductors, motors, and controls.

a) Energize all space heaters furnished with equipment. Provide temporary heating using temporary power or a generator sufficient to prevent condensation in transformers, switchgear, switchboards, motors, and motor control centers, which do not have space heaters.

E. MAINTENANCE

1. Extra Materials:

a) Furnish all spare parts prior to startup. Seal all spare parts in plastic bags and deliver to the Site in a heavy-duty plastic storage box.

b) Furnish all equipment and tools necessary to maintain, program, and calibrate all equipment.

PART 2 PRODUCTS

2.01

A. MANUFACTURERS

1. Each type of electrical material or equipment shall be of the same manufacturer throughout the Work.

B. MISCELLANEOUS

1. Terminal Blocks:

a) Unless otherwise specified, terminal blocks shall be panhead strap screw type. Terminals shall be provided with integral marking strips which shall be permanently identified with the connecting wire numbers as indicated. Terminal blocks for power circuits shall be rated not less than 600 volts AC. Terminal blocks for control circuits and signal circuits shall be rated not less than 20

amps and shall not be rated less than 300 volts AC. Terminals shall be tin-plated. Insulating material shall be nylon. All terminal blocks shall be provided with NFT screws with slotted heads to accept as a minimum 3/16-inch screw driver blades.

b) At each starter, electrical enclosure, control panel, and switchboard, terminate all alarm, control, and any other wiring at indicated numbered terminal blocks.

PART 3 EXECUTION

3.01

A. INSTALLATION

1. Locate and install all equipment so that the equipment will be readily accessible for operation and maintenance. Owner reserves the right to require minor changes in location of outlets or equipment, prior to roughing in, without incurring any additional costs or charges.

   a) Equipment shall not be blocked or concealed.

   b) Do not install electrical equipment such that it interferes with normal maintenance requirements of other equipment.

2. Install Control Building conduit along walls and ceiling, paralleling the existing conduit.

3. Follow the manufacturer's installation instructions unless otherwise indicated.

4. Screen or seal all conduit openings into equipment to prevent the entrance of rodents or insects.

5. To avoid interference with structural members and equipment of other trades, it may be necessary to adjust the intended location of electrical equipment. Obtain Owner approval prior to making modifications.

   a) Particular attention shall be paid to door swings, piping, and building structure.

6. Field paint:

   a) See Section 09900 Painting and Coating.

B. SEISMIC CRITERIA

1. Electrical equipment shall continue to operate within the herein specified operating criteria for the respective electrical equipment if subjected to the seismic forces specified in this Section 16050.

2. Provide all necessary anchoring devices and supports for separately mounted or anchored electrical equipment and appurtenance facilities.

   a) Conform to all requirements of the CBC, both for vertical and seismic Zone 4 loading.

   b) Use supports as indicated and as specified.

(1) Where not indicated or specified, use supports and anchoring devices rated for the equipment load and as recommended by the manufacturer.

c) Supports and anchoring devices shall be rated and sized based on dimensions and weights after equipment submittals are satisfactorily reviewed.

d) Hardware shall be malleable type, corrosion resistant, and shall be supported by heavily plated machine screws or brass, bronze, or stainless steel bolts.

e) Do not cut, or weld to, building structural members.

C. FIELD QUALITY CONTROL

1. Cooperate with Owner and provide assistance at all times for the inspection of the electrical Work. Remove covers, operate machinery, or perform any reasonable Work that, in the opinion of Owner, will be necessary to determine the quality or adequacy of the Work.

2. If any material does not conform to these Specifications, remove the materials from the premises within three Days.

D. CLEANING

1. After installation of wiring and again after commissioning testing, clean starters, panelboards, equipment enclosures, and all other electrical equipment of all dust, dirt, grease, plaster, paint, or other marks.

E. PROTECTION

1. Following installation, protect materials and equipment from corrosion, physical damage, and the effects of moisture on insulation. When equipment intended for indoor installation is installed at Contractor's convenience in areas where it is subject to dampness, moisture, dirt, or other adverse atmosphere until completion of construction, ensure that adequate protection from these atmospheres is provided that is acceptable to Owner. Cap conduit runs during construction.

F. DEMONSTRATION

1. Provide training on recommended routine tests of electrical equipment, including schedule of tests.

2. Provide training on operation, maintenance, and repair of electrical equipment and appurtenances.

3. Allow 8 hours for training.

END OF SECTION

SECTION 16075

ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.01

A. SUMMARY

1. Section Includes:

a) Identification labels for conduit, cable, and electrical equipment

b) Nameplates for electrical equipment

2. Related Sections:

a) Section 16050 (Basic Electrical Materials and Methods)

B. SUBMITTALS

1. See Section 16050 (Basic Electrical Materials and Methods).

2. Product Data:

a) Conduit labels

b) Cable labels

c) Equipment nameplates with lettering size, nameplate size, and proposed inscription

C. WARRANTY

1. Special Warranty:

a) Identification labels and nameplates: 10-year warranty.

PART 2 PRODUCTS

2.01

A. MATERIALS

1. Identification labels for all conductors, cables, and conduit:

a) Manufacturers:

(1) Brady

(2) Seton

(3) Or Approved Equal

2. Furnish and install nameplates and labels to provide equipment identification as indicated.

a) Properly identify with a descriptive nameplate: control panels, push buttons, controls, pull boxes (interior and exterior), instruments, switches, receptacles, panelboards, and motors.

(1) 1/6-inch laminated plastic with black background and white letters.

(2) Letters: 3/8-inch high, minimum

(3) Letters: machine engraved

(4) Screw mounted with oval head machine screws tapped into front of panel

(a) Adhesive material shall not be used

b) Modify panelboard schedules for each circuit added or altered.

3. Label branch circuit wiring with Panel-board name and circuit number, and include "+/-" labels if direct current conductors

4. Identify 120/ 240 circuits with black and white colored insulation conductors at each end and at junction boxes, pull boxes, outlet devices, switching devices, or instrumentation equipment

5. Identify 277/480 and 4160-V along with 12-kV conductors with brown, orange, and yellow insulation or identification tape for A-, B-, and C-phase conductors at each end and at junction boxes, pull boxes, outlet, switching devices, and instrumentation equipment

6. Identify all neutral conductors with white insulation or identification tape at each end and at junction boxes, pull boxes, outlet devices, switching devices, and instrumentation equipment

7. Identify all grounding conductors with green insulation or identification tape at each end and at junction boxes, pull boxes, outlet devices, switching devices, and instrumentation equipment

8. In addition to insulation color coding and identification color coding, number and identify all power, control, and indication wiring by means of wire markers at all switchboards, panel-boards, MCCs, auxiliary gutters, junction boxes, pull boxes, receptacles, outlets, light outlets, manholes, disconnect switches, and circuit breakers. All markers shall correspond to numbers on Project Record Drawings and wiring diagrams. All markers shall consist of machine engraved numbers engraved by an approved marking device.

9. Labels and nameplates shall be completely legible and not smeared.

PART 3 EXECUTION

3.01

A. INSTALLATION

1. Install labels inscribed with cable numbers, panelboard name and circuit number at each end of all power cables and at pull boxes, junction boxes, and all electrical devices.
2. Install labels inscribed with cable numbers and terminal numbers at each end of all control and indication cables and at all pull boxes, junction boxes, and all electrical devices.
3. Nameplates shall be riveted or screwed in place; glue or adhesive material is not acceptable.

B. FIELD QUALITY CONTROL

1. Remove and replace identification labels and nameplates not properly inscribed at Contractor's expense.
2. Replace nameplates installed with glue or adhesive material at Contractor's expense.
3. Nameplates with rivets of screws protruding beyond interior or exterior surface they are affixed to shall be replaced at Contractor's expense.

END OF SECTION

SECTION 16120

CONDUCTORS AND CABLES

PART 1 GENERAL

1.01

A. SUMMARY

1. Section includes:

a) Bus, conductor, and cable, including supports, cable grips, clamps, marking tags, stress cones, shielding kits, terminal connectors, and insulating tape

2. Related Sections:

a) Section 16050 (Basic Electrical Materials and Methods)

B. SUBMITTALS

1. See Section 16050 (Basic Electrical Materials and Methods).

2. Product Data:

a) Bus

b) Conductors, including manufacturer's recommended maximum pulling stress

c) Cables, including manufacturer's recommended maximum pulling stress

d) Supports

e) Cable grips

f) Clamps

g) Marking tags

h) Terminal connectors

i) Insulating tape

j) Wire-pulling compound

PART 2 PRODUCTS

2.01

A. CABLE AND APPURTENANCES

1. All cables, conductors, terminating kits, terminal lugs, and other connectors shall be copper and have insulation rated for at least 167 degrees F (75 degrees Celsius). Aluminum will not be accepted.
2. Terminal lugs shall be solderless-type ring terminal lugs.
   a) Forked or spade lugs will not be permitted.
   b) The insulation in the terminating connectors shall meet or exceed the insulation rating of the conductors.
3. Acceptable manufacturers:
   a) Belden Company
   b) Times Microwave Systems
   c) American Insulated Wire Corporation
   d) Cablec Corporation
   e) Carol Cable Company, Inc.
   f) Rome Cable Corporation
   g) Southwire Company
   h) Ideal
   i) Minnesota Mining and Manufacturing Co.
   j) Penn Union
   k) Thomas and Betts
   l) Or Approved Equal

B. MATERIALS

1. Wire-pulling compound:
   a) Polymer-based formula applicable for all electrical and datacom applications
   b) Designed to lubricate cables for pulling through conduit
   c) Shall not contain petroleum or other products that will deteriorate insulation
   d) Clear and colorless
   e) Easy to clean up
   f) Safe to use with all cable types
   g) Remains stable over wide temperature range

h) Usable from 30 degrees F to 180 degrees F (-1 degrees C to 82 degrees C)

i) Shall not clog conduit

j) Environmentally safe

k) Non-toxic

l) Non-flammable

m) Non-corrosive

PART 3 EXECUTION

3.01

A. INSTALLATION

1. Install conductors in accordance with the indicated conduit schedule and as specified herein, and include supports, cable grips, clamps, marking tags, terminal connections, and insulating tape.

2. Pull conductors into conduits only after the conduit runs have been cleaned, free from obstructions and sharp corners, and successfully mandreled.

3. Install conductors so that there will be no kinks, cuts or abrasions in the insulation or protective covering.

4. Install conductors in single lengths; there shall be no splices.

5. Only gradual and uniform pulling stress, not to exceed that recommended by the manufacturer, will be permitted on wires and cables. Use wire-pulling compound when pulling all conductors.

   a) Remove any conductor that has copper or insulation damage, along with all conductors in that circuit run or conduit, and reinstall new undamaged conductors at Contractor's expense.

6. Tag conductors at each end for identification with marking tags. Identify control and indication wiring as indicated by conductor number. Label branch circuit wiring with panelboard name and circuit number and include "+/-" labels if direct current (dc).

7. Conductors shall be insulated Type TW, THW, THWN, or copper conductors. Sufficient length shall be left at the ends of conductors to make connections convenient to equipment and devices.

8. Install conductors and terminating connectors and terminate all conductors to equipment as indicated.

   a) Terminate conductors using insulated copper compression terminal lugs or stress cones. Bolt lugs to the existing equipment terminals.

b) Use compression tools as recommended by manufacturer when installing terminating lugs so the insulation of the lug is not damaged.

(1) Channel locks and pliers are not acceptable tools to be used to compress terminating lugs.

9. Color Coding and Labeling

a) Color Coding of Low-Voltage Building Wire: Provide color coding throughout the entire network of feeders and circuits (600 volts and below) as follows:

Phase	**120/240 Volts**	**277/480 Volts**
Phase A	Black	Brown
Phase B	Red	Orange
Phase C	Blue	Yellow
Neutral	White	Gray
Ground	Green	Green

b) In addition to color coding, number and identify all power, control, and alarm wiring by means of wire markers at all switchboards, MCCs, panelboards, auxiliary gutters, junction boxes, pull boxes, receptacle outlets, light outlets, manholes, disconnect switches, and circuit breakers. These markers shall correspond to numbers on Project Record Drawings and wiring diagrams. Wire markers shall consist of machine engraved numbers applied by an approved marking device.

B. FIELD QUALITY CONTROL

1. Megger all conductors prior to termination:

a) Megger testing shall include phase-to-phase, phase-to-ground, and phase-to-neutral.

b) Remove and replace conductors failing the megger test with new cable or wire at no additional cost to Owner.

END OF SECTION

SECTION 16130

RACEWAY AND BOXES

PART 1 GENERAL

1.01

A. SUMMARY

1. Section includes:

a) Conduit

b) Conduit supports

c) FS Boxes

d) Pull boxes and junction boxes

e) Duct seal

f) Warning tape

g) Tracer wire

h) Enclosures

2. Related Sections:

a) Section 03405 Precast Concrete Utility Structures

b) Section 16050 Basic Electrical Materials and Methods

B. DEFINITIONS

1. Definitions of types of locations (for purposes of determining enclosure types):

a) Dry location: Indoor area that does not fall within the definitions below for wet, damp, hazardous, or corrosive locations and that are not otherwise indicated.

b) Wet location: Location exposed to the weather, whether under a roof or not, unless otherwise indicated.

c) Damp location: Indoor (or outdoor) location wholly or partially underground, or having a wall or ceiling forming part of a channel or tank, or over water areas on bridges or other supports, or any area subject to water spray, unless otherwise indicated.

d) Hazardous location: Areas indicated as being hazardous locations.

e) Corrosive location: Areas where chlorine or sulfur dioxide gas under pressure, sulfuric acid or liquid polymer are stored or processed.

C. SUBMITTALS

1. See Section 16050 (Basic Electrical Materials and Methods).
2. Product Data:
   a) Conduit, including a complete description of all conduit types to be provided
   b) Conduit supports
   c) FS Boxes
   d) Pull boxes
   e) Junction boxes
   f) Duct seal
   g) Warning tape
   h) Tracer wire
   i) Enclosures
   j) Fittings
3. Shop Drawings:
   a) Proposed conduit routing modifications, if any
   b) FS Boxes
   c) Pull boxes
   d) Junction boxes
   e) Enclosures

PART 2 PRODUCTS

2.01

A. MANUFACTURERS

1. Conduit:
   a) Carlon
   b) Electri-flex
   c) Liquatite
   d) Or Approved Equal
2. FS Boxes:
   a) Appleton
   b) Feraloy
   c) Crouse-Hinds
   d) Or Approved Equal

3. Duct seal:
   a) O.Z.
   b) Gedney DUX
   c) Or Approved Equal
4. Enclosures:
   a) Hoffman
   b) Circle AW
   c) Or Approved Equal

B. CONDUIT

1. Rigid Steel Conduit (RSC) shall be hot dip galvanized on the exterior and may be zinc or enamel on the interior.
   a) Couplings, locknuts, and all other fittings shall be hot dip galvanized.
      (1) All couplings and locknuts shall be of the threaded type only.
   b) Bushings for standard weight rigid steel conduit shall be insulated metallic bushings with insulated plastic throat.
2. Liquid tight Flexible Metallic Conduit (Flex) shall have a flexible galvanized steel core with a copper bonding conductor between the spiral segments, and an extruded, synthetic, liquid-tight jacket.
   a) The maximum length of liquid-tight conduit for each piece of equipment is four feet.
3. Polyvinylchloride Conduit (PVC) shall be rigid heavy weight type
   a) Schedule 40 when encased in concrete
   b) Schedule 80 when exposed or not encased in concrete.
   c) PVC conduit shall be supplied complete with PVC fittings.

C. CONDUIT SUPPORTS

1. UNISTRUT Series P3400 or Approved Equal.
2. Pipe hangers for individual conduits shall be factory made, consisting of a pipe ring and threaded suspension rod. The pipe ring shall be malleable iron, split and hinged, or shall be spring-able wrought steel. Rings shall be bolted to or interlocked with the suspension rod socket.
3. Pipe racks for groups of parallel conduits shall be constructed of galvanized structural steel preformed channels of length as required. Racks or channel shall be suspended on threaded rods and secured with nuts above and below the cross bar or bolted to concrete walls with stainless steel anchors.

4. All holes for support bolts shall be drilled and no power-driven anchors shall be used. Supports and accessories shall be hot-dipped galvanized.

5. Pipe straps shall be the two piece bolted type. Pipe straps shall be coated to be compatible with the conduit (and coating) installed.

D. FS BOXES

1. Cast boxes shall be galvanized, threaded, cast malleable iron. Hub arrangements on threaded fittings shall be the appropriate for the conduit arrangement required in each case to avoid unnecessary conduit bends and fittings.

E. PULL BOXES AND JUNCTION BOXES

1. Provide pull boxes and junction boxes as indicated.

2. Pull boxes shall be Christy No. 3 ½ min, reinforced concrete with bolt down lid, unless otherwise indicated on the plans and these special provisions or Approved Equal.

3. All other pull boxes and junction structures:

a) Marked “ELECTRICAL POWER” or “ELECTRICAL CONTROL,” whichever is appropriate.

b) Wire gutters shall be NEMA 4 with neoprene gaskets on the hinged doors or removable covers.

c) Box and gutter sizes, metal thickness, and installation details shall comply with the NEC.

d) Service splice pull box type and size shall comply with the local utility requirements and specifications

e) For pull boxes in parking areas, traffic rated galvanized steel checked plate cover with bonding jumper shall be used. For pull boxes subject to vehicular traffic, H20 rated minimum with 12”X12” min. concrete collar all around.

F. DUCT SEAL

1. Duct seal shall be non-hardening compound designed for sealing between conduit and electrical cable.

G. WARNING TAPE

1. General:

a) Provide for all buried conduits

2. Materials:

a) Specifically manufactured for warning and identification of buried piping

b) High quality polyethylene base material having a minimum tensile strength of 1500 psi

c) Resistant to acids, alkali, and other detrimental substances normally found in soils

d) Minimum thickness: 0.004 inches

e) Minimum width: 6 inches

f) Color: red

3. Labeling and Coding:

a) Permanent and unaffected by moisture and other substances contained in trench backfill material

b) Provide appropriate color-coding for the utilities involved with warning, as approved by the Owner

c) Imprinted with bold black lettering labeled “Caution – Buried Electrical Line.”

H. TRACER WIRE

1. Lay number 12 THHN insulated copper wire on top of and along the entire length of all buried conduit runs.

2. Extend wire minimum of 6-inches with 2 to 3-inch pigtail above grade, at all points of access, junction boxes, pull-boxes, and where conduits penetrate into buildings.

3. Provide one tracer wire for conduits that are bundled together in a common trench.

4. Make all wire connections with copper crimps wrapped with electrical tape.

5. Provide different color wire insulators for the various utilities involved.

6. Color-coding: as approved by the Owner prior to installation.

I. SERVICE EQUIPMENT ENCLOSURES

1. Service Equipment enclosures shall be Type III-AF (TESCO 26-000 or approved equal), weatherproof enclosures with 16-guage or thicker stainless steel and have continuous welded seams.

2. All enclosures shall have thermostats, heaters, and fans for controlling temperature and moisture within enclosures.

3. All enclosures shall have neoprene gasketed doors.

4. All enclosures shall have a print pocket mounted on door.

5. Service enclosure shall be in accordance with Caltrans Standard Plans ES-2C and ES-2D.

Circuit breakers shall be the cable-in/cable-out type, mounted on non-energized clips. All circuit breakers shall be mounted vertically with the up position of the handle being the "ON" position.

6. Each service shall be provided with up to 2 main circuit breakers which shall disconnect ungrounded service entrance conductors. Where the "Main" circuit breaker consists of 2 circuit breakers as shown on the plans or required in the special provisions, each of the circuit breakers shall have a minimum interrupting capacity of 10,000 A, rms.

J. TELEMETRY PANEL ENCLOSURES

1. Telemetry panel enclosures shall house all the equipment as shown on the drawings.
2. Telemetry panel enclosures shall be weatherproof enclosures with 12-guage or thicker stainless steel and have continuous welded seams.
3. Telemetry panel enclosures shall have thermostats, heater strips, and fans for controlling temperature and moisture within enclosures.
4. All enclosures shall have neoprene gasketed doors.
5. All enclosures shall have a print pocket mounted on door.

PART 3 EXECUTION

3.01

A. INSTALLATION

1. Electrical conduit shall be installed as indicated.
2. Conduit locations may require changes due to existing underground utilities or other unforeseen reasons. Obtain Owner's approval prior to making changes.
3. Conduit installation shall be free from kinks, indentations, or flattened surfaces. Exposed conduit shall run parallel, straight, and true with respect to adjacent construction.
   a) All conduit bends shall be factory bends and shall have at least a 36" bending radius; however, install larger radius sweeps as required by the NEC for larger conductors based on conductor size, insulation type, and shielding or as indicated.
   b) Care shall be taken to prevent the entry of foreign matter into conduits during and after installation.
   c) Open ends shall be closed with threaded plugs or caps until ready to pull wire and cable.
   d) Install a pull string in all conduits and cap the conduits at each end until conductor is pulled. Pull strings shall remain in conduits even after cable is pulled into them. Pull strings shall be tied to enclosures, bushings, or bell ends after installation of conductor.
   e) An appropriately sized mandrel shall be pulled through each conduit prior to pulling any conductor through it. All conduits shall be cleaned and swabbed prior to pulling cable through them.

Notify Owner in writing 2 Days prior to testing and cleaning conduits.

4. Conduit shall terminate in all enclosures with weather-proof lock nuts on both sides of enclosures and a bonding bushing with an insulated plastic throat, on the inside of the enclosure.

   a) Bonding bushings shall be connected to each other, the enclosure they terminate in, and to the grounding electrode using an AWG No. 8 conductor (either bare or green insulated cable).

5. Except as otherwise indicated, conduits shall be separated from pipelines by a minimum of 12 inches on the horizontal when paralleling and a minimum of 6 inches on the vertical when crossing.

6. Underground conduits shall be terminated flush with the finished surface conduit chimneys using a PVC male adapter and capped rigid steel coupling.

   a) Stub-ups from the conduit chimneys to equipment shall be liquid-tight flexible metal conduit installed from the conduit chimney to the equipment terminal box.

   b) Stub-ups from the conduit chimney to panel-boards, control panels, junction boxes, and pull boxes shall be galvanized rigid steel conduit installed from the finished surface of the conduit chimney to the enclosure.

      (1) Install bell ends on the end of all conduits terminated in pull boxes.

   c) PVC schedule 40 conduits shall be installed underground as indicated.

   d) Install conduit 36″ below the finished road surface and stub-up conduits in conduit chimneys and pull boxes as indicated.

   e) All buried conduit shall be marked with warning tape. The tape shall be buried a minimum of 12 inches above the conduit and a minimum of 6 inches below grade.

7. Install pull boxes and junction boxes as indicated.

   a) Install a maximum of 300 feet apart on all conduit runs.

   b) Install additional pull boxes as required, or as the Contractor deems appropriate, at no additional cost to Owner.

8. Unless otherwise indicated, trenching of all new and extended conduit runs installed underground shall be a minimum of 36″ below finished grade.

   a) Conduit shall be covered with an envelope of trench backfill slurry as indicated. The remaining fill to finish grade shall be as indicated.

b) Notify Owner and obtain Owner's approval prior to removal of the concrete and asphalt and notify Owner in writing 3 Days prior to saw cutting or excavating near existing Underground Facilities to allow Owner personnel to be on Site.

9. Unless otherwise noted, types of enclosures to be provided:

a) Dry locations: Provide NEMA 1A or NEMA 12 enclosures.

b) Wet locations: Provide NEMA 3R enclosures.

c) Damp locations: Provide NEMA 4X (316 SS) enclosures.

d) Hazardous locations: Provide NEMA 7 enclosures in areas subject to hazardous gases and NEMA 9 enclosures in areas subject hazardous dust.

e) Corrosive locations: Provide NEMA 4X (non-metal) enclosures.

f) Exceptions:

(1) As modified in other Division 16 Sections.

(2) As otherwise indicated.

END OF SECTION

SECTION 16140

WIRING DEVICES

PART 1 GENERAL

1.01

A. SUMMARY

1. Section Includes:

a) Receptacles

B. SUBMITTALS

1. See Section 16050 (Basic Electrical Materials and Methods).

2. Product Data:

a) Receptacles

PART 2 PRODUCTS

2.01

A. MANUFACTURERS

1. Receptacles:

a) Hubbell

b) Slater

c) P&S

d) Arrow Hart

e) General Electric

f) Leviton

g) Or Approved Equal

B. EQUIPMENT

1. Receptacles for Unclassified Areas:

a) Straight blade, grounding type, specification grade, ground fault circuit interrupter (GFCI) type.

b) Back and side wired with wrap-around bridge.

c) Rated 20 A, 125 V AC, NEMA 5-20R receptacles.

d) UL listed.

e) Test and reset buttons.

f) Color:

(1) For use on normal power: Ivory.

(2) For use on UPS systems: Red.

(3) For use on isolated ground systems: Orange.

g) Wall plate: Type 304 stainless steel.

h) Duplex unless otherwise indicated.

2. Receptacles for Wet Areas:

a) Same as for unclassified areas.

b) Wall plate: Weatherproof with and without cords in place, aluminum, UL listed.

3. Receptacles for Corrosive Areas:

a) Same as for unclassified areas.

b) Color: Yellow.

c) Box: "FS" or "FD" ridge type cast hub box of copper-free aluminum.

d) Gasket: Neoprene.

e) Wall plate: Weatherproof with and without cords in place, aluminum, UL listed.

PART 3 EXECUTION

3.01

A. INSTALLATION

1. Mount devices where indicated and as required per Section 16050 (Basic Electrical Materials and Methods).

2. Surface mount receptacles in concrete construction.

3. In masonry and metal stud construction, recess-mount receptacles unless device precludes recessed mounting or unless otherwise indicated.

4. Where more than one receptacle is installed in a room, arrange symmetrically.

5. Set receptacles plumb and vertical to the floor.

6. Set receptacles flush with face of walls.

7. Provide blank plates for empty outlets.

8. Mount receptacles at heights indicated.

END OF SECTION

SECTION 16150

WIRING CONNECTIONS

PART 1 GENERAL

1.01

A. SUMMARY

1. Section Includes:

a) All connectors and all appurtenances necessary to terminate all electrical equipment and conductors.

2. Related Sections:

a) Section 16050 (Basic Electrical Materials and Methods)

B. SUBMITTALS

1. See Section 16050 (Basic Electrical Materials and Methods)

2. Product Data:

a) Connectors

b) Appurtenant terminating equipment

3. Quality Assurance/Control Submittals:

a) Manufacturer's Instructions:

(1) Installation of connectors and all required appurtenances

PART 2 PRODUCTS

2.01

A. EQUIPMENT

1. All equipment furnished shall be UL listed for the size and type of conductor it will be connected to along with the ampacity and voltage of the associated circuit.

2. Furnish all terminating connectors and terminating appurtenances needed to terminate all power, control, and indication cables and wires for all equipment associated with this Project.

a) Terminating connector insulation shall meet or exceed the insulation rating of the conductors.

B. ACCESSORIES

1. Furnish cable grips and support equipment to prevent stress on conductor lugs.

PART 3 EXECUTION

3.01

A. INSTALLATION

1. Install all connectors and terminating appurtenances necessary to wire all equipment required for this Project.

B. FIELD QUALITY CONTROL

1. Test all connectors and terminating appurtenances in accordance with Contract Documents and NETA standards.

END OF SECTION